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## Rotorcraft Low Altitude CNS Benefit/Cost Analysis

Advanced System Design Service  
Washington, D.C. 20591

## Rotorcraft Operations Data

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16. Abstract  <p>Communications, navigation, and surveillance (CNS) services are readily available at the altitudes flown by most fixed-wing aircraft. They are not, however, always available at the lower altitudes at which most rotary-wing aircraft operate. The objective of this study is to determine if there is an economic basis for improvement of these low altitude CNS services within the National Airspace System ( NAS ) in order to better support rotorcraft operations. The Rotorcraft Master Plan advocates the establishment of additional CNS facilities as well as the analysis and development of systems to satisfy the increasing demand for widespread IFR rotorcraft operations within the NAS. The findings of this study will aid the FAA decisionmaking in that regard. In view of prior implementation decisions on Loran-C, the emphasis in this effort is on communications and surveillance.</p> <p>This interim report provides background data on the rotorcraft industry as it exists today, as well as forecasts to the year 2007 for the purpose of providing operational data for analyses of long-term CNS benefits and costs. It describes rotorcraft missions; selects those most likely to benefit from increased availability of CNS services; identifies the probability of various ceiling and visibility combinations within selected rotorcraft operating areas; and presents an inventory of rotorcraft activity by mission and location.</p>					
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# TABLE OF CONTENTS

	Page
1.0 INTRODUCTION.....	1
2.0 HELICOPTER MISSIONS.....	3
2.1 MISSION CHARACTERISTICS.....	3
2.1.1 Aerial Advertising.....	4
2.1.2 Agriculture.....	4
2.1.3 Air Carrier.....	4
2.1.4 Air Taxi/Commercial.....	4
2.1.5 Bank Paper Transport.....	4
2.1.6 Business.....	5
2.1.7 Construction.....	5
2.1.8 Corporate/Executive.....	5
2.1.9 Electronic News Gathering (ENG).....	5
2.1.10 Emergency Medical Service (EMS).....	5
2.1.11 Exploration.....	6
2.1.12 External Load.....	6
2.1.13 Fire Control Support.....	6
2.1.14 Fish Spotting.....	6
2.1.15 Forestry.....	6
2.1.16 Herding/Ranching.....	6
2.1.17 Law Enforcement.....	7
2.1.18 Logging.....	7
2.1.19 Offshore.....	7
2.1.20 Photography/Movies.....	7
2.1.21 Pollution Detection.....	7
2.1.22 Power/Pipeline Patrol.....	7
2.1.23 Private/Personal Use.....	8
2.1.24 Research.....	8
2.1.25 Sales.....	8
2.1.26 Scheduled Commuter.....	8
2.1.27 Sightseeing.....	8
2.1.28 Search and Rescue.....	9
2.1.29 Skiing/Hiking.....	9
2.1.30 Small Package Delivery.....	9
2.1.31 Survey.....	9
2.1.32 Traffic Reporting.....	9
2.1.33 Training.....	9
3.0 CANDIDATE CNS MISSION SELECTION.....	11
3.1 RELATIVE RANKING OF MISSIONS.....	11
3.1.1 Mission Selection Criteria.....	11
3.1.1.1 Number of Operations.....	11
3.1.1.2 Increased Safety.....	11
3.1.1.3 Increased Efficiency.....	11
3.1.1.4 Time Criticality.....	12
3.1.1.5 Value of Trip.....	12
3.1.2 Mission Characteristic Values.....	12
3.2 DISCUSSION OF MISSION RANKING RESULTS.....	12



By _____	
Distribution/ _____	
Availability Codes _____	
Dist _____	Avail and/or Special _____
A-1	

3.3	BENEFITS DISCUSSION FOR SELECTED MISSIONS.....	15
3.3.1	EMS.....	15
3.3.2	Offshore.....	15
3.3.3	Air Taxi/Commercial.....	16
3.3.4	Search and Rescue.....	16
3.3.5	Business.....	16
3.3.6	Corporate/Executive.....	16
3.3.7	Scheduled Commuter.....	17
3.3.8	Air Carrier.....	17
4.0	HELICOPTER OPERATIONS DATA.....	19
4.1	HELICOPTER SURVEY DATA (1977-1987).....	19
4.1.1	Federal Aviation Administration Survey.....	19
4.1.2	Helicopter Foundation International Survey.....	24
4.1.3	Hospital Aviation Survey.....	24
4.1.4	Helicopter Safety Advisory Conference Survey.....	24
4.1.5	"Rotorcraft Report" Survey of 14 CFR Part 91 Operators.....	24
4.1.6	Airborne Law Enforcement Association Survey.....	24
4.2	AIRCRAFT OPERATIONAL CHARACTERISTICS.....	24
4.2.1	Helicopter Physical Characteristics.....	29
4.2.2	Helicopter Group Characteristics.....	29
4.2.2.1	Light Utility Group.....	29
4.2.2.2	Light Turbine Group.....	31
4.2.2.3	Heavy Turbine Group.....	35
4.2.3	Helicopter Use Trends.....	37
4.3	MISSION OPERATIONAL CHARACTERISTICS.....	37
4.3.1	EMS.....	37
4.3.2	Corporate/Executive.....	43
4.3.3	Scheduled Commuter.....	44
4.3.3.1	Trump Air.....	44
4.3.3.2	New York Helicopters.....	44
4.3.3.3	Hub Express.....	44
4.3.3.4	Digital Equipment Corporation.....	45
4.3.3.5	Los Angeles Helicopters.....	45
4.3.4	Offshore.....	45
4.3.5	Air Taxi/Commercial.....	46
4.3.6	Search & Rescue.....	47
4.3.7	Business.....	47
4.4	HELIPORTS/AIRPORTS PER MISSION.....	48
4.4.1	EMS.....	48
4.4.2	Corporate/Executive.....	48
4.4.3	Scheduled Commuter.....	48
4.4.4	Offshore.....	48
4.4.5	Air Taxi/Commercial.....	48
4.4.6	Search & Rescue.....	48
4.4.7	Business.....	52
4.5	MISSION ROUTE STRUCTURES.....	52
4.5.1	EMS.....	52

4.5.2	Corporate/Executive.....	52
4.5.3	Scheduled Commuter.....	53
4.5.3.1	Trump Air.....	53
4.5.3.2	New York Helicopters.....	53
4.5.3.3	Hub Express.....	53
4.5.3.4	Digital Equipment Corporation (DEC).....	53
4.5.3.5	Los Angeles Helicopters.....	53
4.5.4	Offshore.....	53
4.5.5	Air Taxi/Commercial.....	60
4.5.6	Search and Rescue.....	60
4.5.7	Business.....	60
4.6	HELICOPTER ACCIDENT DATA.....	60
4.6.1	National Transportation Safety Board.....	60
4.6.2	Offshore Accident Rates.....	64
4.6.3	Emergency Medical Service Accident Rates.....	64
4.6.4	Additional Accident Data.....	65
5.0	AREA SELECTION.....	69
5.1	NATIONAL HELICOPTER DISTRIBUTION.....	69
5.2	SELECTED MISSION GEOGRAPHIC REGIONS.....	69
5.2.1	EMS.....	69
5.2.2	Corporate/Executive.....	80
5.2.3	Scheduled Commuter.....	80
5.2.4	Offshore.....	80
5.2.5	Air Taxi/Commercial.....	85
5.2.6	Search and Rescue.....	85
5.2.7	Business.....	85
5.3	WEATHER IMC PROBABILITIES.....	85
5.3.1	CONUS Weather Probabilities.....	86
5.3.2	Offshore Weather Probabilities.....	86
5.3.3	Helicopter Weather Minimums.....	87
5.3.4	Correlation of Weather Data to Helicopter Minimums...	89
5.3.5	Correlation of Weather Data to Helicopter Operating Areas.....	90
6.0	FORECASTS.....	93
6.1	ROTORCRAFT OPERATIONS - HISTORICAL AND FORECAST DATA.....	93
6.1.1	FAA Historical Data.....	93
6.1.2	Helicopter Foundation International Survey.....	96
6.1.3	Hospital Aviation Survey.....	97
6.1.4	Offshore Survey Data.....	97
6.1.5	Scheduled Commuter Data.....	97
6.1.6	ASI Forecast of Helicopter Operations.....	97
6.2	GROWTH RATE FORECAST MODEL.....	99
6.2.1	Estimates of Current Active Helicopters and Flight Hours.....	99
6.2.2	Estimates of Helicopter Growth Rate.....	100
6.2.2.1	Historical Growth Rate, 1977-1987.....	101
6.2.2.2	FAA Forecast Growth Rate.....	101
6.2.2.3	ASI 12-Year Forecast Growth Rate.....	101
6.2.2.4	20-Year Forecast Growth Rate, 1987-2007....	102
6.2.2.5	Summary of Growth Rates.....	102

	<u>Page</u>
6.3 HELICOPTER FLEET CHARACTERISTICS.....	103
6.3.1 Helicopter Aircraft Type Estimates.....	103
6.3.2 Helicopter Operations Estimates.....	103
6.4 FORECAST OF HELICOPTER MISSIONS.....	107
6.4.1 EMS.....	107
6.4.1.1 EMS Flight Hours.....	109
6.4.1.2 EMS Fleet Size.....	109
6.4.1.3 EMS Operations.....	112
6.4.1.4 EMS Operating Area.....	112
6.4.2 Corporate/Executive.....	114
6.4.2.1 Corporate/Executive Flight Hours.....	114
6.4.2.2 Corporate/Executive Fleet Size.....	114
6.4.2.3 Corporate/Executive Operations.....	114
6.4.2.4 Corporate/Executive Operating Area.....	118
6.4.3 Scheduled Commuter.....	118
6.4.3.1 Scheduled Commuter Flight Hours.....	118
6.4.3.2 Scheduled Commuter Fleet Size.....	118
6.4.3.3 Scheduled Commuter Operations.....	120
6.4.3.4 Scheduled Commuter Operating Areas.....	120
6.4.4 Offshore.....	120
6.4.4.1 Offshore Flight Hours.....	120
6.4.4.2 Offshore Fleet Size.....	123
6.4.4.3 Offshore Operations.....	125
6.4.4.4 Offshore Operating Areas.....	125
6.4.5 Search & Rescue.....	125
6.4.5.1 Search and Rescue Flight Hours.....	128
6.4.5.2 Search and Rescue Fleet Size.....	128
6.4.5.3 Search and Rescue Operations.....	130
6.4.5.4 Search and Rescue Operating Area.....	130
6.4.6 Business.....	130
6.4.6.1 Business Flight Hours.....	130
6.4.6.2 Business Fleet Size.....	130
6.4.6.3 Business Operations.....	134
6.4.6.4 Business Operating Area.....	134
6.4.7 Air Taxi/Commercial.....	134
6.4.7.1 Air Taxi/Commercial Flight Hours.....	134
6.4.7.2 Air Taxi/Commercial Fleet Size.....	137
6.4.7.3 Air Taxi/Commercial Operations.....	137
6.4.7.4 Air Taxi/Commercial Operating Area.....	137
6.5 ERROR SOURCES AND EFFECTS.....	137
Annotated Bibliography & Sources.....	143
Acronyms.....	157

# LIST OF TABLES

	<u>Page</u>
Table 1 List of Helicopter Missions.....	3
Table 2 Mission Characteristic Value Matrix.....	13
Table 3 Relative Mission Ranking.....	14
Table 4 Historic Record of Helicopter Missions.....	21
Table 5 Corresponding Primary Use/Mission Types.....	23
Table 6 Scheduled Commuter Helicopter Data.....	27
Table 7 Helicopter Usage Trends.....	28
Table 8 Light Utility Helicopters.....	31
Table 9 Light Utility Helicopter Statistics.....	31
Table 10 Light Turbine Helicopters.....	33
Table 11 Light Turbine Group Statistics.....	33
Table 12 Heavy Turbine Helicopters.....	35
Table 13 Heavy Turbine Group Statistics.....	35
Table 14 Helicopters Flown in Mission.....	37
Table 15 Prior Year Comparisons.....	38
Table 16 Transports by Area.....	38
Table 17 Aeromedical Program Statistics Growth of Hospital-Based Helicopter Programs.....	39
Table 18 Master Aeromedical Helicopter Program Statistics.....	39
Table 19 Corporate/Executive Helicopter Activity in the Northeastern United States.....	43
Table 20 Gulf of Mexico Offshore Helicopter Operators.....	46
Table 21 Air Taxi/Commercial Helicopter Activity in the Northeastern United States.....	47
Table 22 Gulf of Mexico Helicopter Hubs/Heliports.....	50
Table 23 Accidents, Hours, and Accident Rates All Rotorcraft: 1977 - 1986.....	61
Table 24 Accidents, Hours, and Accident Rates Rotorcraft - Reciprocating Engine: 1977 - 1986.....	61
Table 25 Accidents, Hours, and Accident Rates Rotorcraft - Turbine Powered: 1977 - 1986.....	62
Table 26 Rotorcraft Accident Rates by Kinds of Flying: 1977 - 1979....	62
Table 27 HSAC Offshore Accident Rates.....	64
Table 28 Aeromedical Accident Statistics: 1972 - 1988.....	64
Table 29 Accident Statistics - Commercial EMS Helicopters, Title 14 CFR Part 135 Nonscheduled Air Taxi Helicopters, and All Turbine-Powered Helicopters 1980 - 1985.....	65
Table 30 Gulf Coast Helicopter Data.....	71
Table 31 Predominant Helicopter Models in Philadelphia Area.....	71
Table 32 Helicopter Operations by Model in the Philadelphia Area.....	72
Table 33 Predominant Helicopter Models in Boston Area.....	72
Table 34 Helicopter Operations by Model in the Boston Area.....	73
Table 35 Predominant Helicopter Models in New Jersey.....	73
Table 36 Predominant Helicopter Models in the Downstate New York Area.	73
Table 37 ASF Weather Probabilities.....	86
Table 38 Gulf of Mexico SAWRS Locations.....	87
Table 39 VFR Helicopter Minimums.....	88
Table 40 Comparison of Fixed-Wing and Helicopter IFR Minimums.....	88
Table 41 Helicopter Ceiling Probabilities.....	89
Table 42 Helicopter Visibility Probabilities.....	89
Table 43 Offshore Weather Probability Ranges.....	90

	<u>Page</u>
Table 44 Required Probability Ranges.....	90
Table 45 Comparison of the Estimated Active Helicopters Fleets by Use Category for the HFI and GA Surveys.....	96
Table 46 Comparison of the Estimated Rotorcraft Hours Flown by Primary Use Category for the HFI and GA Surveys.....	96
Table 47 Comparison of Helicopter Estimating Factors.....	98
Table 48 Helicopter Fleet Averages 1984-1987.....	100
Table 49 Helicopter Flight Hours 1984-1987.....	100
Table 50 Summary of Helicopter Fleet Size and Hours Flown Growth Rates.....	102
Table 51 Comparison of Estimates of Active Helicopters General Aviation and Avionics Survey and ASI Report.....	106
Table 52 Estimated Helicopter Operations for 1987 By Primary Use.....	107
Table 53 Estimated Additional EMS Helicopters Per Year, 1988-2007....	112

#### LIST OF FIGURES

Figure 1 Survey Questionnaire.....	20
Figure 2 Questionnaire.....	25
Figure 3 EMS Hospital-Based Helicopters.....	26
Figure 4 Helicopter Characteristics.....	30
Figure 5 Light Utility Helicopters.....	32
Figure 6 Light Turbine Helicopters.....	34
Figure 7 Heavy Turbine Helicopters.....	36
Figure 8 EMS Statistical Collection Areas.....	37
Figure 9 Active Hospital-Based EMS Programs.....	40
Figure 10 Number of Helicopters in Hospital-Based EMS.....	41
Figure 11 EMS Patient Transport History.....	42
Figure 12 Distribution of U.S. Emergency Medical Heliports.....	49
Figure 13 Gulf Coast Helicopter Hubs.....	50
Figure 14 Part 135 Operators.....	51
Figure 15 Trump Air.....	54
Figure 16 New York Helicopters.....	55
Figure 17 Hub Express.....	56
Figure 18 Digital Equipment.....	57
Figure 19 Los Angeles Helicopters.....	58
Figure 20 Offshore Helicopter IFR Routes & Helicopter En Route Descent Areas.....	59
Figure 21 Distribution of Accidents in Relation to Kind of Flying.....	63
Figure 22 Accident Rate, Commercial EMS Helicopters and 14 CFR Part 135 Nonscheduled Helicopter Air Taxis 1980-1985.....	66
Figure 23 Accident Rate, Commercial EMS Helicopters and Turbine Engine Helicopters 1980-1985.....	67
Figure 24 Helicopter Distribution in the United States.....	70
Figure 25 Hospital-Based EMS Coverage by Area - Northwest.....	74
Figure 26 Hospital-Based EMS Coverage by Area - Southwest.....	75
Figure 27 Hospital-Based EMS Coverage by Area - North Central.....	76
Figure 28 Hospital-Based EMS Coverage by Area - South Central.....	77

Figure 29 Hospital-Based EMS Coverage by Area - Northeast.....	78
Figure 30 Hospital-Based EMS Coverage by Area - Southeast.....	79
Figure 31 Part 91 Operators.....	81
Figure 32 Scheduled Helicopter Commuter Locations.....	82
Figure 33 Approximate Areas of Federal Offshore Lease Holdings (Texas, Louisiana, Alabama, and Mississippi).....	83
Figure 34 Approximate Areas of Federal Offshore Lease Holdings (Florida).....	84
Figure 35 Fleet Size Forecast FAA Historical Data.....	94
Figure 36 Flight Hour Forecast FAA Historical Data.....	95
Figure 37 CNS Study Fleet Growth Model.....	104
Figure 38 CNS Study Flight Hours Growth Model.....	105
Figure 39 EMS Industry Trends.....	108
Figure 40 Flight Hours Forecasts EMS.....	110
Figure 41 Fleet Forecasts EMS.....	111
Figure 42 Operations Forecasts EMS.....	113
Figure 43 Flight Hours Forecasts Corporate/Executive.....	115
Figure 44 Fleet Forecasts Corporate/Executive.....	116
Figure 45 Operations Forecasts Corporate/Executive.....	117
Figure 46 Flight Hours Forecasts Scheduled Commuter.....	119
Figure 47 Fleet Forecasts Scheduled Commuter.....	121
Figure 48 Operations Forecasts Scheduled Commuter.....	122
Figure 49 Flight Hour Forecasts Offshore.....	124
Figure 50 Fleet Forecasts Offshore.....	126
Figure 51 Operations Forecasts Offshore.....	127
Figure 52 Flight Hour Forecasts Search and Rescue.....	129
Figure 53 Fleet Forecasts Search and Rescue.....	131
Figure 54 Operations Forecasts Search and Rescue.....	132
Figure 55 Flight Hour Forecasts Business.....	133
Figure 56 Fleet Forecasts Business.....	135
Figure 57 Operations Forecasts Business.....	136
Figure 58 Flight Hour Forecasts Air Taxi/Commercial.....	138
Figure 59 Fleet Forecasts Air Taxi/Commercial.....	139
Figure 60 Operations Forecasts Air Taxi/Commercial.....	140

The purpose of this low altitude communications, navigation, and surveillance (CNS) cost/benefit study is to provide analytical material for decision making in implementing new services, procedures, and equipment for improved helicopter operations by area. The Rotorcraft Master Plan (RMP) advocates establishment of additional CNS facilities or the development of alternative systems to satisfy the increased demand for rotorcraft instrument flight rules (IFR) operations. The findings of this study will aid FAA decision making concerning this activity. In view of prior implementation decisions on Loran-C, and an apparent resolution of the navigation issue, the emphasis in this effort will be on communications and surveillance.

Current air traffic control (ATC) services have been designed around fixed-wing IFR operations on designated airways and to and from airports. While rotorcraft frequently operate in the established ATC structure, by so doing they are limited in taking full advantage of their unique operating characteristics. Point-to-point area navigation capability and ability to operate to and from any location cannot be fully used because at many locations and altitudes used by rotorcraft, ATC services are not available. Both the FAA and rotorcraft operators have expressed a need for enhanced low altitude CNS services.

To evaluate the cost/benefit of increased CNS low altitude service in support of rotorcraft, the first task is to identify the types of work or missions that helicopters perform. Two sources were used to accomplish this task. The first was the Aerospace Industries Association (AIA) Directory of Helicopter Operators in the United States, Canada, Mexico and Puerto Rico. Although this directory is no longer being published, the last edition was recent (1985-1986) and provided a comprehensive list of helicopter missions. The second source is the 1988 Helicopter Annual published by the Helicopter Association International (HAI). The annual lists all the missions in which its member helicopter operators engage. A comprehensive list was prepared, confirmed through discussion with industry contacts, and is presented in Table 1.

TABLE 1  
LIST OF HELICOPTER MISSIONS

Aerial Advertising	Law Enforcement
Agriculture	Logging
Air Carrier	Offshore
Air Taxi/Commercial	Photography/Movies
Bank Paper Transport	Pollution Detection
Business	Power/Pipeline Patrol
Corporate/Executive	Private/Personal Use
Construction	Research
Exploration	Sales
External Load	Scheduled Commuter
Electronic News Gathering (ENG)	Search and Rescue
Emergency Medical Service (EMS)	Sightseeing
Fire Control Support	Skiing/Hiking
Fish Spotting	Survey
Forestry	Small Package Delivery
Herding/Ranching	Traffic Reporting
	Training

## 2.1 MISSION CHARACTERISTICS

A mission profile and set of flight characteristics for each helicopter mission listed in Table 1 was developed so that each mission could be evaluated in terms of potential benefits resulting from increased low altitude CNS services. All helicopter missions flown are subject to 14 CFR Part 91, "General Operating and Flight Rules." 14 CFR Part 127, "Certification and Operation of Scheduled Air Carriers with Helicopters," prescribes rules governing air carriers engaged in scheduled interstate transportation within the 48 contiguous states and D.C., having a passenger seating capacity greater than 30 seats and a payload capacity greater than 7,500 pounds. External load operations are governed by 14 CFR Part 133, "Rotorcraft External Load Operations." 14 CFR Part 135, "Air Taxi Operators and Commercial Operators," prescribes rules governing air taxi operations, the transportation of mail conducted under a postal service contract, the carriage of persons or property for compensation or hire in aircraft having a maximum seating capacity of 20 passengers or a maximum payload capacity of less than 6,000 pounds, and the carriage of persons or property between points

entirely within any U.S. state in aircraft having a maximum seating capacity of 30 seats or less or a maximum payload capacity of 7,500 pounds or less. Missions excepted from 14 CFR Part 135 applicability include student instruction, emergency mail service, aerial work operations, ferry or training flights, nonstop sightseeing flights that begin and end at the same location and are conducted within a 25 statute mile radius of that location, and other specific flights as listed in 14 CFR Part 135.1.

#### 2.1.1 Aerial Advertising

Aerial advertising requires a helicopter to fly at a reasonably low altitude over areas where its advertising will be seen. The helicopter is equipped with a sign, which is attached to its side expressing what is being advertised. The mission is not performed in poor visual conditions since the advertising cannot be seen. The helicopter must follow the rules applicable to the airspace in which it is flying. This ranges from uncontrolled airspace to operations conducted entirely within a terminal control area.

#### 2.1.2 Agriculture

Helicopters are used in agriculture primarily to apply insecticide or other substances that are sprayed onto crops. These missions fly at very low altitudes and perform frequent takeoffs and landings to refill the material being sprayed. Due to the nature of the mission it is not performed in poor visibility.

#### 2.1.3 Air Carrier

Air carrier missions need to operate in all weather and flight conditions in order to guarantee their schedules to their customers. Because the primary function of this mission is to provide an alternative to ground transportation, most often in congested areas, it operates in areas of heavy concentrations of population that often coincide with strictly controlled airspace. The altitudes at which they operate are at or below altitudes used by fixed-wing aircraft. Therefore, a high degree of CNS capability is required.

#### 2.1.4 Air Taxi/Commercial

The operational requirements of air taxi or commercial (for compensation or hire) missions vary with the type of job the operator has been hired to perform. On-demand air taxi or commercial missions that are used to carry passengers have a greater degree of flexibility than air carrier missions because they do not have to meet specific schedules and can therefore choose not to fly in poor weather. However, the more often they can fly the more satisfied the customers and the better their business will be.

#### 2.1.5 Bank Paper Transport

Within the last decade banks began using helicopters to transport financial documents, canceled checks, etc., from the bank's downtown headquarters to separate processing centers, usually located in more

suburban locations, and to airports for national/international distribution. This is profitable for many financial institutions where the interest accrued/saved through faster transfer of funds more than pays for the helicopter operation. Generally, only major banks located in major metropolitan areas can afford this type of operation. These helicopters fly in urban areas, usually in controlled airspace and sometimes in marginal weather conditions.

#### 2.1.6 Business

Business missions are primarily flown in support of small businesses by the owner of the helicopter as an alternative to ground transportation. The helicopters used are usually single-engine piston aircraft which are required to fly, at times, in marginal weather conditions. The flight characteristics depend on the geographic location and airspace requirements.

#### 2.1.7 Construction

Helicopters used for construction either help in the actual construction or are used to transport workers and materials to and from the construction site. This may include external load operations. Operations are normally conducted within a small area at very low altitudes, either in uncontrolled airspace or in coordination with the local ATC facility. Due to the nature of the mission, it is conducted in visual conditions.

#### 2.1.8 Corporate/Executive

Corporate/executive missions carry executives and other employees for company or individual business. The level of activity of the corporate/executive mission depends on the economic well-being of those businesses that use helicopters. In addition, the more often the helicopter can fly in all weather conditions the more economically attractive is its use. Helicopters used for this purpose are an alternative not only to ground transportation, but to short-haul, fixed-wing flights and sometimes to commercial fixed-wing transportation. Therefore, corporate/executive missions try to fly the most direct route possible under prevailing conditions. Since the origins and destinations often change, no specific routes are assigned, and altitudes are determined by local ATC and weather conditions.

#### 2.1.9 Electronic News Gathering (ENG)

Electronic news gathering helicopter activity occurs primarily in major urban areas. Helicopters fly to areas where newsworthy events are happening, making established routes impractical. They fly at all altitudes, in varying airspace categories and in as many weather conditions as can safely be maneuvered.

#### 2.1.10 Emergency Medical Service (EMS)

Emergency medical service helicopters are used to fly accident victims or critically ill patients to the location where they can receive the best medical treatment. EMS operations are conducted over established routes between contracting hospitals or to and from the site

of an accident and an appropriate medical treatment facility. These operational scenarios are, on the average, divided on a 70 percent/30 percent ratio respectively. While most EMS operators do not currently operate IFR, there is a percentage who do and the percentage is increasing.

#### 2.1.11 Exploration

Helicopters are used for oil, precious metal and mineral exploration. In some applications a magnetometer is hung from the helicopter to conduct low level searches for metals, while geiger counters are used to locate radioactive materials such as uranium. Helicopters also carry seismic equipment to determine the presence of oil beneath the earth's surface during explosion tests. Most exploration missions are used to verify the quality and/or quantity of a substance since the location has usually been predetermined by the presence of certain rock formations and satellite images. Helicopters are also used for mapping as well as moving equipment and supplies. These operations are normally performed in remote areas and under visual conditions.

#### 2.1.12 External Load

External load operations require the helicopter to carry heavy and/or bulky objects hung from a cable or other device under the helicopter. This type of use is often found in construction applications, such as installation of large air conditioners on high-rise buildings. Due to the nature of this mission, it is often performed in urban areas, at very low altitudes, under visual conditions only. Airspace control is determined by location.

#### 2.1.13 Fire Control Support

Helicopters are used for fire fighting by independent fire departments or as an adjunct to other public service institutions like police departments or forest services. This mission is performed at low altitudes, in both urban and rural settings, in most weather conditions.

#### 2.1.14 Fish Spotting

In this mission, helicopters are employed to fly within a specified radius of a fishing boat to locate schools of fish such as tuna, for commercial fishing purposes. While the base of operations is at a coastal location, this mission is performed over the ocean in uncontrolled airspace in visual conditions.

#### 2.1.15 Forestry

Helicopters are used in forest management to transport workers for planting, cutting, and for other care and supervisory needs. It is performed in rural areas, under visual or marginal weather conditions, and in uncontrolled airspace.

#### 2.1.16 Herding/Ranching

Helicopters are used by ranchers and the forest service to herd domestic livestock and wildlife. After the animals are herded they are sometimes counted. Ranching involves the transport of workers and

supplies to do manual labor such as repairing fences. This mission is performed in rural areas, at low altitudes, under visual or marginal weather conditions, and in uncontrolled airspace.

#### 2.1.17 Law Enforcement

Police departments and other law enforcement agencies use helicopters for patrolling, for investigating reports of criminal activity, for pursuing suspects, and for traffic control. This type of mission is performed in both urban and rural settings at a variety of altitudes, under visual conditions, in both controlled and uncontrolled airspace, during both day and night.

#### 2.1.18 Logging

Helicopters are used to support the logging industry by transporting workers and for the carrying of external loads. The logging mission is performed in rural areas, at low altitudes, under visual or marginal weather conditions, and in uncontrolled airspace.

#### 2.1.19 Offshore

Helicopters are used for transporting workers and equipment from onshore bases to offshore rigs, and between rigs. Precise navigation to the rigs is critical. The mission requires operation in all weather conditions. This mission operates in both controlled and uncontrolled airspace at a variety of altitudes.

#### 2.1.20 Photography/Movies

Helicopters are used by those persons wishing to take pictures from an aerial perspective. This mission can be performed in both rural and urban settings, but must be performed in good weather. Helicopters performing this mission fly at a range of altitudes consistent with the subjects being photographed and the equipment being used. In controlled airspace coordination with the local ATC facilities is important due to the unpredictability of routing that the photography may require.

#### 2.1.21 Pollution Detection

Pollution detection missions are flown in visual conditions and usually below 1500 feet above ground level (AGL). Mid-size helicopters (2-10 place) are most often used for flying this mission. Missions are extensive and involve high-technology scientific equipment. Typical missions include acid rain and turbidity testing of rivers and lakes and sampling of air and smoke stack plumes for the presence of polluting gases.

#### 2.1.22 Power/Pipeline Patrol

Power and energy companies must continually account for the integrity of their lines and perform routine and emergency maintenance in remote locations to ensure proper service. Helicopters have been found to be an effective tool to patrol for voltage (hot spots) and gas leakage. This activity is performed primarily in rural areas, at very low altitudes, under visual or marginal weather conditions, and in uncontrolled airspace.

#### 2.1.23 Private/Personal Use

Some individuals have purchased helicopters for their own personal use. These individuals fly their helicopters on unspecified point-to-point routes in varying weather conditions depending upon personal and aircraft certification aircraft equipage, currency, and confidence. They may fly in controlled or uncontrolled airspace depending on the needs of the individual.

#### 2.1.24 Research

Helicopters are used for a variety of research efforts by manufacturers, Government agencies, and academia. This mission includes certification flight testing of new models or modifications to current helicopters, research and development testing of new designs or components, and support to Government or business flight tests for other aircraft. Flights are usually conducted in visual or marginal weather conditions and may be in controlled or uncontrolled airspace.

#### 2.1.25 Sales

Helicopters are used for demonstration and temporary loan purposes to conduct sales. Individuals and manufacturers may demonstrate an aircraft's capabilities or provide a pilot and aircraft to potential buyers for the purpose of demonstrating the applicability of the specific aircraft to their business/mission. This helicopter use may encompass any mission meeting the buyer's needs.

#### 2.1.26 Scheduled Commuter

Scheduled commuter operations are expected to increase as ground transportation congestion worsens in urban areas. Such service is often started as a means of getting from suburban and/or downtown locations to major air carrier airports. It may then expand to include routes between urban activity centers.

Scheduled commuter missions are essentially "air carrier" operations, but because helicopters with less than 30 seats are used, they usually operate under 14 CFR Part 135. Still, this mission has the same reliability requirements as air carriers and must be able to operate in all weather and flight conditions to guarantee the schedule to customers. Since the primary purpose of this mission is to provide an alternative to ground transportation, it often operates in heavily populated and congested metropolitan areas that often coincide with strictly controlled airspace. Usually, the altitudes at which the helicopters must operate are at or below those used by fixed-wing aircraft. Generally, due to the regularity of their origins and destinations, routes are established through formal or informal agreements with the controlling ATC facilities.

#### 2.1.27 Sightseeing

The sightseeing mission is located in areas that attract a significant number of tourists. Specific areas where this mission can be found include the Grand Canyon in Arizona, Hawaii, Alaska, and New York City.

Sightseeing helicopters fly in visual conditions, at altitudes that allow the sights to be seen, and in controlled or uncontrolled airspace depending on the location.

#### 2.1.28 Search and Rescue

Search and rescue operations are flown by public service, law enforcement, EMS, military, and occasionally private helicopter operators in response to emergency situations. This mission is performed in rural, remote, and over water locations, at low altitudes, and under visual or marginal weather conditions in uncontrolled airspace.

#### 2.1.29 Skiing/Hiking

In recent years helicopter operators have offered both helicopter skiing and hiking. The helicopter is used to transport skiers/hikers to remote, normally inaccessible places. This mission is performed in rural or wilderness areas at altitudes appropriate to the location, under visual or marginal weather conditions, and in uncontrolled airspace.

#### 2.1.30 Small Package Delivery

Small package delivery by helicopter has become increasingly competitive with other means by providing guarantees to their customers for prompt, reliable delivery. To increase their efficiency, these services are using helicopters to carry small packages (previously delivered by ground transport) from metropolitan airports to urban heliports. This mission primarily operates in urban settings, in visual or marginal weather, and in controlled or uncontrolled airspace.

#### 2.1.31 Survey

The survey mission usually involves resurveying of areas last surveyed in the early 1900's. These missions are flown under visual flight rules (VFR) and involve the use of very precise inertial navigation systems to fly the coordinates, direction, and altitudes required. Survey missions include mapping and gravity surveying.

#### 2.1.32 Traffic Reporting

In urban areas, where there is high population and traffic congestion, many radio and/or television stations use helicopters to report traffic conditions during rush hours or when an unusual event affects traffic. This mission is performed at relatively low altitudes, and in visual or marginal weather conditions, in controlled and uncontrolled airspace.

#### 2.1.33 Training

Helicopter pilot training schools may be located in either rural or urban settings. The Government, military, and the private sector train new pilots and provide advanced training and additional ratings for previously licensed helicopter pilots. Training is performed under visual conditions even for most helicopter IFR ratings and may include night and "under the hood" training exercises. Schools are often located on or near an airport and must follow the regulations governing the local airspace.

## 3.1 RELATIVE RANKING OF MISSIONS

A detailed analysis is required to identify and quantify the benefits associated with improved low altitude CNS service. Rather than diffusing available resources over all mission types, only those missions thought most likely to derive significant benefits from improved low altitude CNS service were selected for detailed analysis. This selection was accomplished by developing criteria that highlight potential benefits for low altitude CNS service.

3.1.1 Mission Selection Criteria

The selection criteria were based on the operating characteristics and the environment associated with each mission as described in Section 2.1. The selection criteria are:

- o Number of Operations
- o Increased Safety
- o Increased Efficiency
- o Time Criticality
- o Value of Trip

3.1.1.1 Number of Operations

The number of annual operations for each mission was considered as a criterion for mission selection. As the number of operations increases, the benefits for that mission due to increased or improved low altitude CNS service also increase.

3.1.1.2 Increased Safety

The relative increased safety realized per mission due to improved or increased low altitude CNS services was selected as a mission selection criterion. Safety benefits are accrued through potential reductions in the number of aircraft accidents, the severity of aircraft accidents, or the effects of accidents.

3.1.1.3 Increased Efficiency

An increase in mission efficiency which results from increased or improved low altitude CNS service was also a criterion for mission selection. Efficiency benefits result from an increase in the number of operations per mission, reduced mission times, or the ability to perform a greater number of operations to/from a specific location.

#### 3.1.1.4 Time Criticality

Time dependence per mission was a criterion for mission selection. For some missions the probability of meeting mission time constraints are greatly improved with an increase or improvement in low altitude CNS service, thus bettering the chances for mission completion and the accrual of the benefits associated with that mission.

#### 3.1.1.5 Value of Trip

The last mission selection criterion was the value of a trip. This value is based on considerations such as the mission's involvement in saving lives, resources and property, or the mission's relationship to customer profits and success.

#### 3.1.2 Mission Characteristic Values

Mission types were subjectively ranked relative to each mission selection criterion category. Rankings of 1 through 5 were applied with 5 representing the greatest value and 1 the least value. The number of operations per mission was relatively ranked for both current (1987) and forecast future (2007) timeframes. The six criteria were assessed independently with the following equation being used to determine each mission's total score:

$$TS = O_N \times (1.5S + E + T + V)$$

TS = Total Score

$O_N$  = Number of Operations

S = Increased Safety

T = Time Criticality

V = Value of Trip

E = Increased Efficiency

The methodology used in this equation accounts for the increased importance of safety relative to the other criteria.

Total mission scores were determined for both 1987 and forecast for 2007 as shown in Table 2. Table 3 illustrates the relative ranking of missions as determined from total scores for 1987 and 2007.

#### 3.2 DISCUSSION OF MISSION RANKING RESULTS

The same missions consistently occur within the top seven places for both the 1987 and 2007 rankings. In the 1987 ranking, significant breaks between the top mission scores occur between corporate/executive and search and rescue, and between search and rescue and business. In the 2007 ranking, a break occurs between corporate/executive and emergency medical service, and again between scheduled commuter and business. Because scheduled commuter benefits due to increased or improved low altitude CNS service are expected, by 2007, to be of the same magnitude as those for search and rescue and emergency medical service, the scheduled commuter mission is included in the group of missions to be studied in greater detail.

TABLE 2  
MISSION CHARACTERISTIC VALUE MATRIX  
(Sorted Alphabetically by Mission)

<u>Mission</u>	# Ops 1987	# Ops 2007	Safety	Effic.	Time Crit.	Trip Value	1987 Total Score	2007 Total Score
Aerial Advertising	1	1	1	1	2	1	6	6
Agriculture	5	5	1	1	1	3	33	33
Air Carrier	1	2	5	5	5	4	22	43
Air Taxi/Commercial	5	5	4	4	4	3	85	85
Bank Paper Transport	1	1	2	2	4	3	12	12
Business	3	3	4	3	4	3	48	48
Construction	1	1	1	1	2	3	8	8
Corporate/Executive	5	5	4	3	4	3	80	80
Electronic News Gathering	2	2	3	3	5	2	29	29
Emergency Medical Service	2	3	5	4	5	5	43	65
Exploration	1	1	1	1	1	2	6	6
External Load	1	1	1	1	2	3	8	8
Fire Control Support	2	2	2	3	5	5	32	32
Fish Spotting	1	1	1	1	2	1	6	6
Forestry	1	1	1	1	1	2	6	6
Herding/Ranching	1	1	1	1	1	2	6	6
Law Enforcement	3	3	2	1	4	4	36	36
Logging	2	2	1	1	1	1	9	9
Offshore	5	5	4	5	4	4	95	95
Photography/Movies	1	2	1	1	1	2	6	11
Pollution Detection	1	1	1	1	1	2	6	6
Power/Pipeline Patrol	1	1	1	1	1	2	6	6
Private/Personal Use	3	3	4	3	2	2	39	39
Research	1	1	1	1	1	2	6	6
Sales	1	1	1	1	1	3	7	7
Scheduled Commuter	2	3	4	5	5	4	40	60
Search and Rescue	3	3	5	4	5	5	65	65
Sightseeing	2	2	4	1	1	1	18	18
Skiing/Hiking	1	1	1	1	1	1	5	5
Small Package Delivery	2	3	2	3	4	3	26	39
Survey	1	1	1	1	1	2	6	6
Traffic Reporting	2	3	3	1	5	2	25	38
Training	3	3	3	2	1	1	26	26

TABLE 3  
RELATIVE MISSION RANKING  
(Sorted by Relative Ranking)

Mission	1987	Mission	2007
	Total Score		Total Score
Offshore	95	Offshore	95
Air Taxi/Commercial	85	Air Taxi/Commercial	85
Corporate/Executive	80	Corporate/Executive	80
Search and Rescue	65	Emergency Medical Service	65
Business	48	Search and Rescue	65
Emergency Medical Service	43	Scheduled Commuter	60
Scheduled Commuter	40	Business	48
Private/Personal Use	39	Air Carrier	43
Law Enforcement	36	Private/Personal Use	39
Agriculture	33	Small Package Delivery	39
Fire Control Support	32	Traffic Reporting	38
Electronic News Gathering	29	Law Enforcement	36
Small Package Delivery	26	Agriculture	33
Training	26	Fire Control Support	32
Traffic Reporting	25	Electronic News Gathering	29
Air Carrier	22	Training	26
Sightseeing	18	Sightseeing	18
Bank Paper Transport	12	Bank Paper Transport	12
Logging	9	Photography/Movies	11
Construction	8	Logging	9
External Load	8	Construction	8
Sales	7	External Load	8
Aerial Advertising	6	Sales	7
Exploration	6	Aerial Advertising	6
Fish Spotting	6	Exploration	6
Forestry	6	Fish Spotting	6
Herding/Ranching	6	Forestry	6
Photography/Movies	6	Herding/Ranching	6
Pollution Detection	6	Pollution Detection	6
Power/Pipeline Patrol	6	Power/Pipeline Patrol	6
Research	6	Research	6
Survey	6	Survey	6
Skiing/Hiking	5	Skiing/Hiking	5

### 3.3 BENEFITS DISCUSSION FOR SELECTED MISSIONS

The missions expected to derive the greatest benefits from increased low altitude CNS services are:

- o EMS
- o Offshore
- o Air Taxi/Commercial
- o Search and Rescue
- o Business
- o Corporate/Executive
- o Scheduled Commuter

#### 3.3.1 EMS

The EMS mission ranked sixth in 1987 and fourth in 2007 in terms of benefits due to increased or improved low altitude CNS services. The number of operations is average in relation to the other missions, but is expected to grow. Rankings of 5, however, were made for EMS safety benefits, time criticality, and trip value. EMS trip value is the greatest for all missions ranked, as benefits due to the number of lives saved (mortality) and the reduction of the severity and long-term effects of injuries (morbidity) are immense. Time criticality of EMS operations is of primary importance. EMS missions also benefit highly from increased safety associated with low altitude CNS service improvement. Accident rates for the EMS mission have, before 1986, been almost twice as large as accident rates for all turbine-powered rotorcraft. The added safety provided by increased low altitude CNS service would contribute to a reduction of this rate. Efficiency benefits were ranked as 4 for EMS missions as additional trips can be completed that otherwise would not be conducted.

#### 3.3.2 Offshore

The offshore mission ranked first in both 1987 and 2007 in terms of benefits associated with increased or improved low altitude CNS service. The relative ranking of 5 for the number of operations for both 1987 and 2007 illustrates that offshore operations would continue to be one of the leading missions in terms of activity. Although the offshore accident rate is low compared to the accident rate for all turbine rotorcraft, additional safety benefits would accrue due to improved low altitude CNS service. Efficiency benefits for the offshore mission achieve a ranking of 5 due to the relief in offshore traffic congestion that would be provided by improved or increased low altitude CNS service. Rankings of 4 were also made for time criticality and trip value. The value of a trip is lower than EMS because during normal operations no lives are saved. However, it remains high because of the dependence of offshore rig operations upon the helicopter for crew and equipment transportation. Time criticality was also ranked high because delays in equipment delivery and/or crew changes create additional costs for offshore operators in terms of paid overtime for personnel and interruptions in operations.

### 3.3.3 Air Taxi/Commercial

The air taxi/commercial mission benefits rank second for both 1987 and 2007. As defined for this study, the air taxi/commercial mission encompasses all Part 135 operators except for those conducting offshore, scheduled commuter, or emergency medical services operations. The number of air taxi/commercial operations is of the same order of magnitude as offshore and corporate/executive operations. Rankings of four were made for the safety, efficiency, and time criticality benefit categories. Safety increases with improved low altitude CNS especially during air taxi/commercial operations in marginal weather. With appropriate ATC coordination operations could become more efficient at some locations. Although air taxi/commercial missions are on-demand and not scheduled, time criticality is essential to customer satisfaction. The trip value received an average ranking as the transport of passengers or property can usually be done with alternate slower modes of transportation.

### 3.3.4 Search and Rescue

The search and rescue mission ranked fourth in 1987 and fifth in 2007 based on total benefits associated with improved or increased low altitude CNS service. Although the number of operations for 1987 and 2007 was average compared to other missions ranked, the mission scored 5, the highest rank, for three of the four remaining benefit categories. Efficiency benefits accrue with increased or improved low altitude CNS for search and rescue because missions can be flown in marginal weather that otherwise could not be conducted. Since many search and rescue operations are conducted in marginal weather, a prime contributor to accidents, safety improvements accrue with increased low altitude CNS service. Time is critical to the success of the mission as the chance for location and survival of a victim decreases with an increase in response time. The trip value ranking is of the same magnitude as for the EMS mission because of the benefits associated with saving lives and reduced morbidity.

### 3.3.5 Business

The business mission ranked fifth in 1987 and seventh in 2007. The number of operations is average when compared to the other missions ranked. Safety benefits accrue primarily during marginal weather operations and also because of communications and surveillance services provided in uncontrolled airspace where a large amount of business missions are flown. Improved low altitude CNS service aids the business mission in meeting schedules critical to the business' success. Additional business missions may be flown due to increased efficiency. The value of a trip is ranked a 3 to illustrate that the business mission's success is not strictly dependent upon the helicopter.

### 3.3.6 Corporate/Executive

The corporate/executive mission benefits ranked third for both 1987 and 2007. The number of operations was ranked a 5 as its magnitude is of the same order as offshore and air taxi/commercial operations.

Efficiency for the corporate/executive mission increases moderately as more flights may be conducted due to enhanced low altitude CNS service. Safety benefits increase due to improved communications and surveillance service in and around city centers having characteristically high traffic densities. As corporate/executive missions are usually flown to meet an individual's or company's schedule, the chances of meeting the planned schedule improve with increased low altitude CNS. Trip value is ranked moderate since success of the trip is not dependent upon helicopter transportation as alternative slower transportation modes are usually available.

#### 3.3.7 Scheduled Commuter

The scheduled commuter mission ranked seventh in 1987 and sixth in 2007 with respect to benefits associated with increased or improved low altitude CNS service. The number of scheduled commuter operations is small but expected to grow by 2007. Time criticality is of prime importance to meet and guarantee schedules. Efficiency benefits also accrue with an increase in the number of operations due to increased low altitude CNS service. Safety benefits were also ranked high and are primarily associated with operations in IFR conditions. The value of a trip is above average in comparison with the other missions ranked, and is dependent upon the success of the helicopter as an alternate mode of transportation in congested areas.

#### 3.3 8 Air Carrier

The air carrier mission using helicopters was not chosen to be studied in detail due to the non-existence of operations today and the small number of operations expected by 2007 (Tiltrotor will be addressed under separate cover). All other benefit categories ranked high because of the air carrier mission's operating environment and time constraints. However, the availability of low altitude CNS is essential to the growth and existence of the air carrier mission.

This section presents the helicopter operations data gathered from a variety of sources for use in this study. Lack of data, and when data was available, lack of data consistency, severely constrains proper analysis. We have attempted to correlate these data and construct a true perspective of today's and tomorrow's helicopter operations. Helicopters were classified based on their weight and power characteristics into three groups; light utility, light turbine, and heavy turbine. These groups were analyzed to determine individual mission dependencies on helicopter weight and power characteristics. Additionally, operations, heliports, and route structures for the missions determined in Section 3.0 to benefit most by increased or improved low altitude CNS were analyzed in detail and the results presented here.

#### 4.1 HELICOPTER SURVEY DATA (1977-1987)

The following is a discussion of six recently conducted surveys by various segments of the helicopter industry. The results of five of the surveys have been incorporated into this study. The sixth, by the Airborne Law Enforcement Association, is not yet complete and will be used in a later part of the study when it becomes available.

##### 4.1.1 Federal Aviation Administration Survey

The FAA publishes the General Aviation Activity and Avionics Survey annually. A sampling technique is employed in which questionnaires are mailed to a certain percentage of general aviation aircraft and helicopter owners. Figure 1 is a sample of that survey. For example, in 1986 about 10 percent of the general aviation aircraft owners and 25 percent of the helicopter owners were sampled. The samples are selected from the Aircraft Registration Master File database of registered aircraft owners. The survey data is reduced by cataloging responses according to primary use (the activity in which the aircraft accumulated the most hours). Statistical information is developed for each primary use including the number of active aircraft by type, region, and weather and light conditions encountered.

The results from this survey are published in the FAA Statistical Handbook of Aviation and are shown for comparative purposes in Table 4.

The FAA Statistical Handbook of Aviation published for each calendar year, tracks rotorcraft activity by the number of annual hours flown for each primary use (mission). These data are compiled from the results of the General Aviation Activity and Avionics Survey. The FAA uses 12 categories of primary use that incorporate, but these do not coincide strictly with the missions previously listed in Section 2.0. These primary uses are:

Executive  
Business  
Personal  
Instructional  
Aerial Application  
Aerial Observation

Other Work  
Commuter/Air Carrier  
Air Taxi  
Rental  
Industrial  
Other

FIGURE 1  
SURVEY QUESTIONNAIRE

1. CONTROL NUMBER		GENERAL AVIATION ACTIVITY AND AVIONICS SURVEY (As of December 31, 1986)		Form Approved OMB NO. 2120-0060																																																																																																					
<p>This report is authorized by Section 311 of the Federal Aviation Act of 1958, as amended. While you are not required to respond, your cooperation is needed to make the results of this survey comprehensive, accurate and timely. Information collected in this survey will be used for statistical purposes only by FAA to plan and manage air traffic facilities and services and not to disclose individual activity.</p>																																																																																																									
<p>INSTRUCTIONS: Please answer questions for the aircraft at right. Mail the completed questionnaire in the enclosed postage paid envelope to:</p>		<p>2. AIRCRAFT CHARACTERISTICS</p> <p>Transportation Systems Center-GAF Kendall Square Cambridge, Massachusetts 02142</p>																																																																																																							
<p>3. In 1986, did you operate this aircraft primarily as a scheduled air carrier under FAR Parts 121 or 127 (large aircraft) or as a charter aircraft for such an air carrier?</p> <p><input type="checkbox"/> NO (Please answer remaining questions. This form should be completed for all general aviation aircraft and aircraft operated under Part 135, commuter and on-demand air taxi.)</p> <p><input type="checkbox"/> YES (Do not complete the rest of this form, but return to address shown above.)</p>		<p>10. In 1986, what percent of the hours did this aircraft fly under the following conditions? (a, b, c, and d should add to 100%)</p> <table border="1"> <tr> <td>Day Flying</td> <td>%</td> </tr> <tr> <td>Visual (VTC)</td> <td>a</td> </tr> <tr> <td>Instrument (IMC)</td> <td>b</td> </tr> <tr> <td>Night Flying</td> <td>%</td> </tr> <tr> <td>Visual (VMC)</td> <td>c</td> </tr> <tr> <td>Instrument (IMC)</td> <td>d</td> </tr> <tr> <td>TOTAL</td> <td>100%</td> </tr> </table>				Day Flying	%	Visual (VTC)	a	Instrument (IMC)	b	Night Flying	%	Visual (VMC)	c	Instrument (IMC)	d	TOTAL	100%																																																																																						
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<p>4. In what state (abbreviation) or foreign country was this aircraft based as of December 31, 1986? _____</p>		<p>11. Was this aircraft flown on an Instrument Flight Plan in 1986?</p> <p>1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p> <p>If "Yes," how many hours were flown on an Instrument Flight Plan? _____</p>																																																																																																							
<p>5. Was the aircraft flown in Calendar Year 1986?</p> <p>1. <input type="checkbox"/> Yes 2. <input type="checkbox"/> No (Skip to question 12.)</p>		<p>12. What were the total lifetime airframe hours as of December 31, 1986? _____</p>																																																																																																							
<p>6. How many hours did this aircraft fly in each of the categories below during the Calendar Year 1986? Please estimate use for rental &amp; leased hours.</p> <table border="1"> <tr> <td>EXECUTIVE/CORPORATE TRANSPORTATION- Company flying with a professional crew</td> <td>a</td> </tr> <tr> <td>BUSINESS TRANSPORTATION- Individual use of an aircraft for business transportation</td> <td>b</td> </tr> <tr> <td>PERSONAL- Flying for personal reasons (excludes business transportation)</td> <td>c</td> </tr> <tr> <td>INSTRUCTIONAL- Flying under the supervision of a flight instructor (excludes proficiency flying)</td> <td>d</td> </tr> <tr> <td>AERIAL APPLICATION- Agriculture, health, forestry, cloud seeding, firefighting, insect control, etc.</td> <td>e</td> </tr> <tr> <td>AERIAL OBSERVATION- Aerial mapping/photography, survey, patrol, fish spotting, search and rescue, hunting, highway traffic advisory, sightseeing (not FAR Part 135) etc.</td> <td>f</td> </tr> <tr> <td>OTHER WORK USE- Construction work (not FAR Part 135), helicopter hoist, parachuting, aerial advertising, towing gliders, etc.</td> <td>g</td> </tr> <tr> <td>COMMUTER AIR CARRIER- Performs under FAR Part 135, at least five scheduled round trips per week or carries mail</td> <td>h</td> </tr> <tr> <td>AIR TAXI- FAR Part 135 passenger and cargo operations excluding commuter air carrier. What was the average revenue (dollars) per hour for this aircraft in air taxi operation?</td> <td>i</td> </tr> <tr> <td>OTHER- Experimentation, R&amp;D testing, demonstrations, government, air shows, air racing, etc.</td> <td>j</td> </tr> </table>		EXECUTIVE/CORPORATE TRANSPORTATION- Company flying with a professional crew	a	BUSINESS TRANSPORTATION- Individual use of an aircraft for business transportation	b	PERSONAL- Flying for personal reasons (excludes business transportation)	c	INSTRUCTIONAL- Flying under the supervision of a flight instructor (excludes proficiency flying)	d	AERIAL APPLICATION- Agriculture, health, forestry, cloud seeding, firefighting, insect control, etc.	e	AERIAL OBSERVATION- Aerial mapping/photography, survey, patrol, fish spotting, search and rescue, hunting, highway traffic advisory, sightseeing (not FAR Part 135) etc.	f	OTHER WORK USE- Construction work (not FAR Part 135), helicopter hoist, parachuting, aerial advertising, towing gliders, etc.	g	COMMUTER AIR CARRIER- Performs under FAR Part 135, at least five scheduled round trips per week or carries mail	h	AIR TAXI- FAR Part 135 passenger and cargo operations excluding commuter air carrier. What was the average revenue (dollars) per hour for this aircraft in air taxi operation?	i	OTHER- Experimentation, R&D testing, demonstrations, government, air shows, air racing, etc.	j	<p>13. AVIONICS EQUIPMENT CAPABILITY ("X" ALL boxes that reflect this aircraft's current capability. If none, check the last box in each group.)</p> <p>VHF COMMUNICATIONS EQUIPMENT</p> <table border="1"> <tr> <td>360 Channels or less</td> <td>a</td> </tr> <tr> <td>720 Channels or more</td> <td>b</td> </tr> <tr> <td>More than One Communications System</td> <td>c</td> </tr> <tr> <td>No VHF Communications Equipment</td> <td>d</td> </tr> <tr> <td>TRANSPONDER EQUIPMENT</td> <td></td> </tr> <tr> <td>4096 Code</td> <td>e</td> </tr> <tr> <td>Altitude Encoding Equipment</td> <td>f</td> </tr> <tr> <td>No Transponder Equipment</td> <td>g</td> </tr> <tr> <td>NAVIGATION EQUIPMENT</td> <td></td> </tr> <tr> <td>VOR Receiver</td> <td></td> </tr> <tr> <td>100 Channels</td> <td>h</td> </tr> <tr> <td>200 Channels</td> <td>i</td> </tr> <tr> <td>More than One VOR Receiver</td> <td>j</td> </tr> <tr> <td>Automatic Direction Finder (ADF)</td> <td>k</td> </tr> <tr> <td>Distance Measuring Equipment (DME)</td> <td>l</td> </tr> <tr> <td>Area Navigation Equipment (RNAV)</td> <td>m</td> </tr> <tr> <td>Long Range Navigation Equipment</td> <td>n</td> </tr> <tr> <td>LORAN C</td> <td>o</td> </tr> <tr> <td>OMEGA-VLF</td> <td>p</td> </tr> <tr> <td>Other (Doppler, INS, Other)</td> <td>q</td> </tr> <tr> <td>Radar Altimeter</td> <td>r</td> </tr> <tr> <td>Weather Radar</td> <td>s</td> </tr> <tr> <td>No Navigation Equipment</td> <td>t</td> </tr> <tr> <td>PRECISION APPROACH EQUIPMENT</td> <td></td> </tr> <tr> <td>Localizer</td> <td>u</td> </tr> <tr> <td>Marker Beacon</td> <td>v</td> </tr> <tr> <td>Glide Slope</td> <td>w</td> </tr> <tr> <td>Microwave Landing System</td> <td>x</td> </tr> <tr> <td>No Precision Approach Equipment</td> <td>y</td> </tr> <tr> <td>GUIDANCE AND CONTROL EQUIPMENT</td> <td></td> </tr> <tr> <td>Flight Director</td> <td>z</td> </tr> <tr> <td>Horizontal Situation Indicator (HSI)</td> <td>aa</td> </tr> <tr> <td>Electronic Flight Instrument System (EFIS)</td> <td>bb</td> </tr> <tr> <td>Flight Management Computer</td> <td>cc</td> </tr> <tr> <td>Autopilot</td> <td>dd</td> </tr> <tr> <td>1 Axis (Wing Leveler)</td> <td>ee</td> </tr> <tr> <td>2 Axis (Heading and Track)</td> <td>ff</td> </tr> <tr> <td>3 Axis (Heading, Track, and Altitude)</td> <td>gg</td> </tr> <tr> <td>Autoland</td> <td>hh</td> </tr> <tr> <td>No Guidance and Control Equipment</td> <td>ii</td> </tr> </table>				360 Channels or less	a	720 Channels or more	b	More than One Communications System	c	No VHF Communications Equipment	d	TRANSPONDER EQUIPMENT		4096 Code	e	Altitude Encoding Equipment	f	No Transponder Equipment	g	NAVIGATION EQUIPMENT		VOR Receiver		100 Channels	h	200 Channels	i	More than One VOR Receiver	j	Automatic Direction Finder (ADF)	k	Distance Measuring Equipment (DME)	l	Area Navigation Equipment (RNAV)	m	Long Range Navigation Equipment	n	LORAN C	o	OMEGA-VLF	p	Other (Doppler, INS, Other)	q	Radar Altimeter	r	Weather Radar	s	No Navigation Equipment	t	PRECISION APPROACH EQUIPMENT		Localizer	u	Marker Beacon	v	Glide Slope	w	Microwave Landing System	x	No Precision Approach Equipment	y	GUIDANCE AND CONTROL EQUIPMENT		Flight Director	z	Horizontal Situation Indicator (HSI)	aa	Electronic Flight Instrument System (EFIS)	bb	Flight Management Computer	cc	Autopilot	dd	1 Axis (Wing Leveler)	ee	2 Axis (Heading and Track)	ff	3 Axis (Heading, Track, and Altitude)	gg	Autoland	hh	No Guidance and Control Equipment	ii
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<p>7. Was the aircraft rented or leased to others in 1986?</p> <p>1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p> <p>If "Yes," how many rental or leased hours? _____</p>		<p>14. What were the maintenance expenses for this aircraft in 1986? _____</p>																																																																																																							
<p>8. What was this aircraft's average rate of fuel consumption (gals/hour)?</p> <p>Estimate the percent of each fuel and grade used</p> <table border="1"> <tr> <td>Jet fuel</td> <td>b</td> </tr> <tr> <td>Aviation fuel</td> <td></td> </tr> <tr> <td>80 Octane</td> <td>c</td> </tr> <tr> <td>100 Octane</td> <td>d</td> </tr> <tr> <td>100 Octane Low Lead</td> <td>e</td> </tr> <tr> <td>Automotive Gasoline</td> <td>f</td> </tr> <tr> <td>Total (b, c, d, e, f should add to 100%)</td> <td>100%</td> </tr> <tr> <td>What was the average cost per gal? _____</td> <td>g</td> </tr> </table>		Jet fuel	b	Aviation fuel		80 Octane	c	100 Octane	d	100 Octane Low Lead	e	Automotive Gasoline	f	Total (b, c, d, e, f should add to 100%)	100%	What was the average cost per gal? _____	g	<p>15. What was the cost to insure this aircraft in 1986? (Include liability, medical and hull) _____</p>																																																																																							
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<p>9. How many landings, including touch and go landings, did this aircraft perform in each of the following categories during Calendar Year 1986?</p> <table border="1"> <tr> <td>Number of landings in local flight</td> <td>a</td> </tr> <tr> <td>Number of landings in cross-country flight</td> <td>b</td> </tr> </table>		Number of landings in local flight	a	Number of landings in cross-country flight	b	<p>16. Do you own one or more ultralights?</p> <p>1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No</p> <p>If "Yes," how many _____ and how many hours in total was it (were they) flown? _____</p>																																																																																																			
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<p>17. Comments</p> <p>Your comments are invited to assist us in improving this survey. Please use reverse side of this form.</p>																																																																																																									

TABLE 4  
HISTORIC RECORD OF HELICOPTER MISSIONS  
HOURS FLOWN (X 1000)

Year	Total	Exec	Bus	Pers	Inst- ruct	Aer Appl	Aer Obs	Other Work	Commu- ter	Air Taxi	Rent	In- dust	Other
1977													
#	1,868	120	158	24	208	201	NR	NR	NR	698	11	165	275
%		6%	9%	1%	11%	11%	-	-	-	37%	.6%	9%	15%
													(99.6%)
1978													
#	2,228	267	138	27	100	219	NR	NR	NR	828	74	211	365
%		12%	6%	1%	5%	10%	-	-	-	37%	3%	10%	16%
													(100%)
1979													
#	2,555	302	234	42	59	314	NR	NR	NR	1,032	7	310	260
%		12%	9%	2%	2%	12%	-	-	-	40%	.3%	12%	10%
													(99.3%)
1980													
#	2,338	380	258	34	69	240	NR	NR	2	440	195	496	204
%		16%	11%	2%	3%	10%	-	-	.09%	19%	8%	21%	9%
													(99.9%)
1981													
#	2,685	937	279	34	80	347	296	160	10	372	4	NR	206
%		35%	10%	1%	3%	13%	11%	6%	.4%	14%	.2%	-	8%
													(101.6%)
1982													
#	2,350	456	50	25	125	196	313	148	0	721	34	NR	281
%		19%	3%	1%	5%	8%	13%	6%	0%	31%	2%	-	12%
													(100%)
1983													
#	2,271	765	60	24	163	204	181	207	10	552	3	NR	117
%		34%	3%	1%	7%	9%	8%	9%	.4%	24%	.1%	-	5%
													(101.4%)
1984													
#	2,495	224	76	41	178	167	340	46	8	887	21	NR	287
%		10%	3%	2%	8%	7%	15%	2%	.3%	39%	.9%	-	13%
													(100.2%)
1985													
#	2,155	306	190	54	114	203	490	111	11	437	19	NR	216
%		14%	9%	3%	5%	9%	23%	5%	.5%	20%	.9%	-	10%
													(99.4%)
1986													
#	2,625	356	99	38	140	247	450	64	133	803	NR	NR	296
%		14%	4%	2%	5%	9%	17%	2%	5%	31%	-	-	11%
													(100%)
1987													
#	2,283	231	78	47	129	230	360	70	5	890	NR	NR	244
%		10%	3%	2%	6%	10%	16%	3%	.2%	39%	-	-	11%
													(100.2%)

NR = Not Reported

Source: FAA Statistical Handbook of Aviation, Calendar Years 1977-1987

The definitions for each of these primary uses and how they conform to the list of helicopter missions in Section 2.0 are discussed below. Table 5 shows approximately equivalent primary uses and missions. Note that, in some instances, the mission categories fit into two or more FAA categories.

Executive. Aircraft used by a company, corporation, or other organization to transport employees and/or property, not for compensation or hire, but employing professional pilots. This includes corporate/executive, company-owned, offshore transport, and bank paper transfer.

Business. Aircraft not for compensation or hire, used by individuals for the purposes of transportation required by the business in which they are engaged. This includes corporate/executive and offshore.

Personal. Aircraft used for personal purposes not associated with business or profession, and not for compensation or hire. This includes maintenance of pilot proficiency.

Instructional. Aircraft used for formal pilot instruction, either with an instructor, or under the guidance of an instructor. This excludes proficiency flying.

Aerial Application. Aircraft used for work purposes which concerns the production of foods, fibers and health control in which the aircraft is used in lieu of farm implements or ground vehicles for the particular task accomplished. This includes firefighting operations, the distribution of chemicals or seeds in agriculture, reforestation, or insect control.

Aerial Observation. Aircraft used for aerial mapping/photography, survey patrol, fish spotting, search and rescue, hunting, highway traffic advisory or sightseeing, and not included under 14 CFR Part 135.

Other Work. Any aircraft used for construction work, helicopter hoist, towing gliders or parachuting, and not included under 14 CFR Part 135.

Commuter/Air Carrier. An air taxi that performs at least five scheduled round trips per week between two or more points or that carries mail.

Air Taxi. Aircraft used for nonscheduled "on demand" transportation, and scheduled flights of less than five round trips per week, operating under 14 CFR Part 135, passenger and cargo operations, including charter and excluding commuter/air carrier.

Rental. Aircraft owned for the purpose of renting; commercial flying club, leased, and rental aircraft activity. This category is no longer used.

Industrial. Any aircraft used for specialized work allied with industrial activity excluding transportation and aerial application. This was replaced by "aerial observation" and "other work" and is no longer used.

Other. All other uses of an aircraft not included under the categories listed above.

TABLE 5  
CORRESPONDING PRIMARY USE/MISSION TYPES

FAA Primary Use	Corresponding Mission Type
Executive	Bank Paper Transport Corporate/Executive Offshore Business
Business	Corporate/Executive Offshore
Personal	Private/Personal Use
Instructional	Training
Aerial Application	Agriculture Fire Control Support Forestry
Aerial Observation	Exploration Electronic News Gathering Fish Spotting Forestry Law Enforcement Photography/Movies Power/Pipeline Patrol Pollution Detection Sightseeing Search and Rescue Traffic Reporting
Other Work	Aerial Advertising Construction External Load Herding/Ranching Logging
Commuter/Air Carrier	Scheduled Commuter Small Package Delivery Air Carrier
Air Taxi	Air Taxi/Commercial Skiing/Hiking Corporate/Executive Offshore
Rental (No longer used)	
Industrial (No longer used)	Now Equivalent to Aerial Observation Plus Other Work
Other	Emergency Medical Service Sales Research

#### 4.1.2 Helicopter Foundation International Survey

A one-time survey was conducted in 1988 by the Helicopter Foundation International (HFI). HFI surveyed the entire registered civilian helicopter fleet to obtain a database independent of the General Aviation Survey database described in paragraph 4.1.1. Helicopter owners were identified from the Rotor Roster, a privately published version of the FAA Aircraft Registration Master File containing only rotorcraft. The questionnaire used is shown as Figure 2. Questionnaires were mailed to 8,539 aircraft owners. A 42.8 percent response rate was achieved. Of the 2,200 responses received only 1,675 were complete enough to be used for statistical purposes. Applied Systems Institute (ASI) compiled the results of the survey and compared them to the General Aviation and Avionics Survey.

#### 4.1.3 Hospital Aviation Survey

Howard Collett, editor of Hospital Aviation, conducts an annual survey of many aspects of the hospital-based aeromedical operators. Much of the data have been used for this study.

#### 4.1.4 Helicopter Safety Advisory Conference Survey

The Helicopter Safety Advisory Conference (HSAC) conducts an annual survey of the Gulf Coast helicopter operators. The results of the last 4 years surveys are included in this study.

#### 4.1.5 "Rotorcraft Report" Survey of 14 CFR Part 91 Operators

In July 1988, the publishers of Rotor & Wing International surveyed 14 CFR Part 91 helicopter operators. This survey was used to define corporate/executive operating characteristics and problems more clearly.

#### 4.1.6 Airborne Law Enforcement Association Survey

Currently the Airborne Law Enforcement Association (ALEA) is conducting a survey of aviation use by the 335 law enforcement agencies in the United States. The survey is planned to be completed by August 1989 and will include helicopter as well as fixed-wing statistics. When the survey becomes available, it will be used to determine the number of non-hospital-based EMS and search and rescue operations.

### 4.2 AIRCRAFT OPERATIONAL CHARACTERISTICS

Aircraft operational characteristics play an important role in mission use with capabilities ranging from near primitive, by today's standards, to the high-tech glass cockpit using the latest state-of-the-art technology. With technological advances come changes in mission use, which in turn lead to overall fleet modernization and new or refined mission applications.

Aircraft characteristics for the EMS and scheduled commuter missions are presented in Figure 3 and Table 6, respectively. Figure 3 illustrates the variation of helicopters used for the EMS mission over a 5-year period, from July 1984 through July 1988. The most prominent

FIGURE 2  
QUESTIONNAIRE

Please complete and return this questionnaire. Your response is kept confidential.

S/N _____		Please answer the following questions regarding this and return by 7/28/88.	
What is the aircraft total time? _____ as of what date? _____		Who is the current owner? _____	
Is it airworthy? (Y) (N) If no, is it repairable? (Y) (N)		If military surplus give military s/n _____	
Is it certified IFR? (Y) (N) Are pilots IFR rated? (Y) (N)		Total hours flown in 1987? _____	
Were you asked to complete the GA survey form within the last three years? (Y) (N) Did you complete it? (Y) (N)		Average flight length (in min)? _____	
What is your operations base zip code? _____		Average landings hourly? _____	
May we call for clarification? (Y) (N) Phone _____		What % is flown over following areas (Should total 100%)	
		Remote Areas	
		BELOW 500' AGL _____	
		ABOVE 500' AGL _____	
		Populated areas	
		BELOW 500' AGL _____	
		ABOVE 500' AGL _____	
Please indicate the percentage of time your aircraft was used in 1987 for the following uses.			
(Total should equal 100%)			
	Govt		Govt
	Related Executive		Related
Commuter flights	_____ % (Y) (N)	Business	_____ % (Y) (N)
155 Charter	_____ % (Y) (N)	Personal	_____ % (Y) (N)
R & D Testing	_____ % (Y) (N)	Instruction	_____ % (Y) (N)
E/S/Ordn transport	_____ % (Y) (N)	Aerial application	_____ % (Y) (N)
Construction	_____ % (Y) (N)	Aerial observation	_____ % (Y) (N)
SAR/Police	_____ % (Y) (N)	Rental	_____ % (Y) (N)
This survey, directed by Helicopter Foundation International, in cooperation with the FAA is designed to provide a comprehensive description on the US civil rotary wing community. The data derived from this survey can have a major impact on FAA forecasts and services. Your response is important. It is vital for the future of the helicopter industry that forecasts be based on the most accurate data available. If you would like more information on this study please call Bob Kerner, National Director, Helicopter Foundation International, at 703-583-4646, or Rich Adams, Program Director, 509-259-9726.			



Helicopter Foundation International  
Mr. Bob Kerner, National Director  
1619 Duke Street  
Alexandria, VA 22314-3406



# EMS HOSPITAL BASED HELICOPTERS

Figure 3

REFERENCE: HOSPITAL AVIATION, JULY 1988

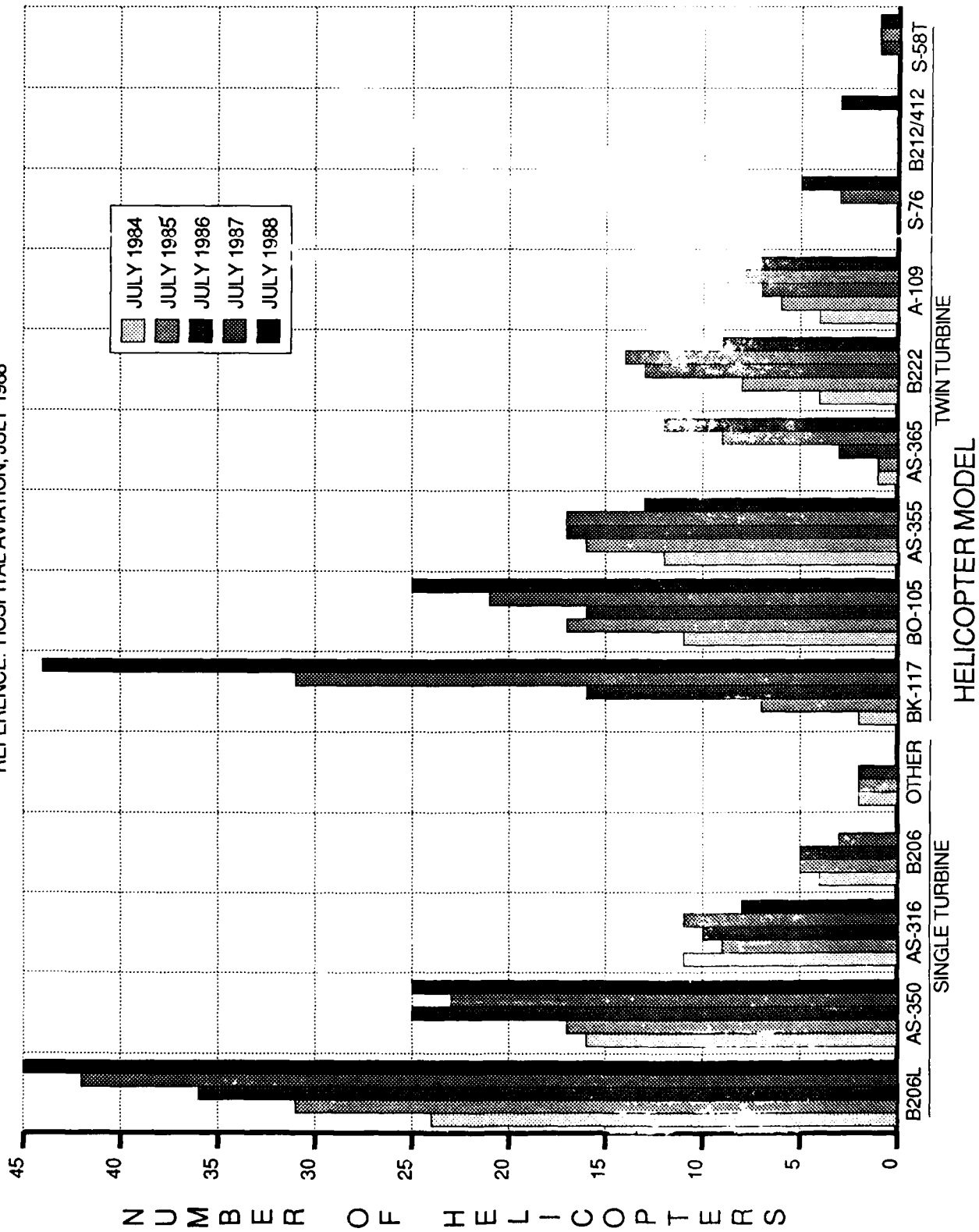


TABLE 6  
SCHEDULED COMMUTER HELICOPTER DATA

Commuter Helicopter		IFR		
Name	Model	Equipped	VOR	LORAN-C
Digital	B206	No	1	1
Digital	B206	No	1	1
Digital	B206	No	1	1
Digital	B206	No	1	1
Digital	B206	No	1	1
Digital	B206	No	1	1
Digital	B222UT	Yes	1	1
Trump	S61	Yes	2	1
Trump	S61	Yes	2	1
Trump	S61	Yes	2	1
Hub Exp	B206E3	No	1	1
Hub Exp	B206LI	No	1	1
NYHeli	S58-T	No	1	0
NYHeli	S58-T	No	1	0
NYHeli	S58-T	No	1	0
NYHeli	S58-T	No	1	0
LAHeli	A-Star	No	1	0
LAHeli	A-Star	No	1	0

Source: Discussions with Scheduled Commuter Operators.

models used for EMS missions are the Bell 206L and MBB BK-117. The use of these two models has continued to grow steadily. MBB's BO-105 and Aerospatiale's AS-350 are the next most popular aircraft for the EMS mission.

Table 6 illustrates the types of aircraft and their instrument equipage currently used for the scheduled commuter mission. Each operator has chosen specific manufacturer's helicopters and, for the most part, specific models to use in their commuter operations. The most predominately used scheduled commuter is the Bell 206, of which Digital Equipment Corporation (considered a scheduled commuter for purpose of this study: see 4.3.3.4) operates 6 and Hub Express operates two variants. Sikorsky helicopters follow close behind with New York Helicopter's four S-58T's and Trump Air's three S-61's. Most scheduled commuter aircraft are not currently IFR-equipped, but do have VOR and Loran-C.

Data on specific models of helicopters were available from the ASI database records and were examined to find trends in parameters of interest. The ASI database records were sorted by helicopter model and records with either missing or zero flight hours were considered to be inactive during 1987 and were removed. There were 1,735 helicopters in the database. Of these, 1,359 (78.3 percent) had flight hours recorded and 376 (21.7 percent) had zero or unreported flight hours. The average percent of time flown in the database's 13 mission categories, flight hours per year, and flight length (in minutes) was tabulated and averaged for each model. The results are shown in Table 7.

TABLE 7  
HELICOPTER USAGE TRENDS

MAKE/MODEL	MOD NO	HRS	AVERAGE PERCENT OF TOTAL TIME FLOWN												
			APPL	BUS	COMM	EMS	EXEC	INST	PERS	RES	SAR	TAXI	OBS	WORK	OTHR
BRANTLY-HYNES	B28	73	0	45	0	0	0	4	51	0	0	0	0	0	0
ENSTROM	F-28	143	1	42	2	0	1	9	26	0	6	2	9	0	4
HUGHES	269	435	7	12	0	0	0	10	12	0	28	1	22	6	2
HUGHES	369	466	6	27	1	0	2	1	3	0	27	8	12	11	2
ROBINSON	R-22	369	2	34	2	0	0	33	14	0	1	2	4	2	6
SIKORSKY	S-55	104	50	17		0	0	0	33	0		0	0	0	0
SIKORSKY	S-58	228	0	0	0	0	0	0	0	0	33	0	0	67	0
SIKORSKY	S-58T	548	0	0	40	0	0	0		0		0	0	40	0
SIKORSKY	S-61	780	0	0	67	0	0	0	0	0	0	0	0	33	0
SIKORSKY	S-76	757	0	17	0	0	24	0	0	0	0	58	0	0	0
AGUSTA	A-109	213	0	51	0	14	22	0	3		0	8	0	0	2
AEROSPATIALE	AS-316	600	0	0	0	90	0	0	0	0	0	10	0	0	0
AEROSPATIALE	AS-350	464	2	27	1	39	7	1	2		0	21	3	0	1
AEROSPATIALE	AS-355	714	0	13	0	21	5	0	3	0	0	59	0	0	0
AEROSPATIALE	AS-365	284	0	0	0	66	32	1	1	0	0	0	0	0	0
AEROSPATIALE	AS-315	1005	0	0	0	0	0	0	0	0	0	9	80	11	0
BELL	204	273	65	0	0	5	0	6	0	4	1	0	18	0	1
BELL	205	333	33	0	0	33	0	0	0	0	33	0	0	0	0
BELL	206	614	2	14	1	8	6	1	1	1	7	51	5	2	1
BELL	212	617	0	0	0	0	0	0	0	5	2	73	9	6	5
BELL	214ST	503	0	0	0	4	0	0	0	17	13	33	0	16	17
BELL	222	314	0	49	8	0	10	0	0	9	5	9	0	0	17
BELL	412	1451	0	0	0	10	0	0	0	13	0	73	0	0	4
BELL	47	257	44	6	0	1	0	10	8	1	5	3	12	8	2
MBB	BO-105	466	0	4	0	58	11	0	0	0	0	25	1	1	0
MBB	BK-117	620	0	0	0	97	3	0	0	0	0	0	0	0	0
BELL	UH-1	124	41	4	0	2	8	1	0	3	24	0	2	12	3
HILLER	UH-12	221	46	10	0	0	0	5	14	0	2	1	16	6	0
HILLER	FH-1100	247	48	0	0	0	0	0	0	0	38	0	15	0	0
BOEING VERTOL	BV-107	1090	0	0	0	0	0	0	0	0	0	0	0	100	0
BOEING VERTOL	BV234	1090	0	0	0	0	0	0	0	0	0	0	0	100	0

MOD NO = Model Number  
HRS = Average Annual Hours Flown  
APPL = Aerial Application  
BUS = Business  
COMM = Scheduled Commuter  
EMS = Emergency Medical Service  
EXEC = Executive  
INST = Instruction  
PERS = Personal  
RES = Research  
SAR = Search and Rescue  
TAXI = Air Taxi  
OBS = Aerial Observation  
WORK = Other Work  
OTHR = Other Missions  
FLT LNTH = Flight Length

Source: Analysis of ASI Database Records.

The mission characteristics represented by the percent time flown in each category were plotted in the form of bar graphs in order to construct a profile of use for each model. These profiles were then examined to determine models with similar usage patterns. In most cases helicopter mission is correlated with the type of engine, i.e., piston or turbine, and the size of the helicopter.

#### 4.2.1 Helicopter Physical Characteristics

The operator mission profile data was compared to aircraft characteristics from the Official Helicopter Specification Book to determine any other trends in mission categories with helicopter physical characteristics.

The key parameters used to distinguish helicopters were the total horsepower rating for takeoff, the number of engines, the type of engine (turbine or piston), and the maximum gross weight. Using these parameters as a basis, a chart of current and planned helicopter characteristics was generated.

Figure 4 shows a strong correlation between maximum gross weight and takeoff horsepower as would be expected by the requirement for helicopters to hover. Along this trend line, helicopters tend to form groups within gross weight and horsepower ranges. These groups were examined further by plotting together the mission profiles of all helicopters in each category. Examining these plots, specific trends in mission could be determined. Helicopter models close to the initial gross weight and horsepower boundaries were included in a group if they exhibited similar mission profile characteristics.

Three major groups emerged based on weight, horsepower, and mission category. These were identified as the Light Utility Group, the Light Turbine Group, and the Heavy Turbine Group.

#### 4.2.2 Helicopter Group Characteristics

The helicopter models in each group and the percentage of the active population are discussed below.

##### 4.2.2.1 Light Utility Group

The light utility group consisted of single engine piston and turbine helicopters ranging from 1700 to 4000 pounds gross weight and 160 to 500 takeoff horsepower. Models in this group and the estimated active population are shown in Table 8. In the light utility group the ASI sample consisted of 630 helicopters which 17.1 percent was of the ASI estimated active population of helicopters in this group.

Figure 4  
**HELICOPTER CHARACTERISTICS**  
 WEIGHT AND POWER TRENDS

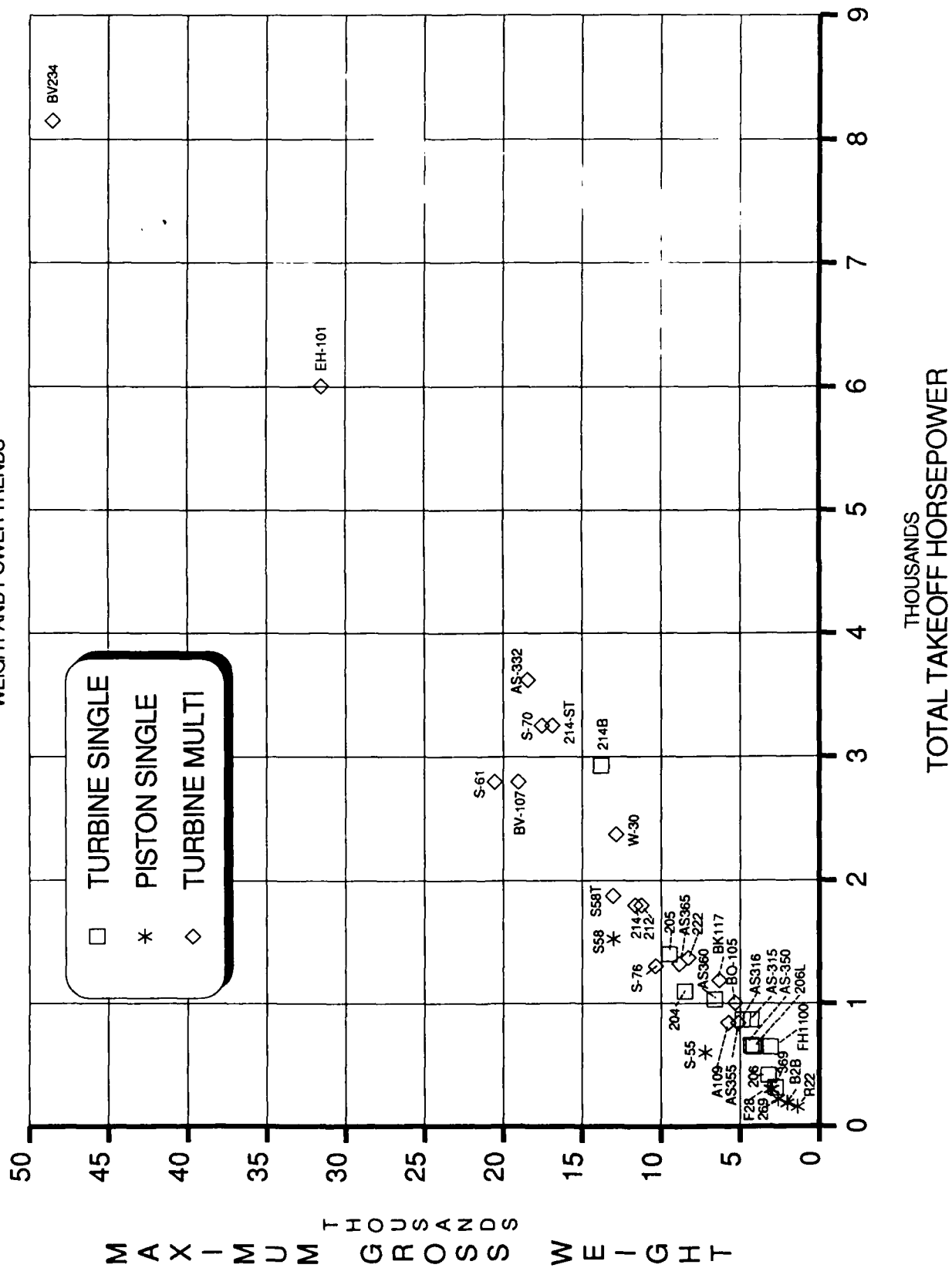


TABLE 8  
LIGHT UTILITY HELICOPTERS

Model	Estimated Active
Bell UH-1*, 204*, and 205* series	28
Bell 47 and H-13 series	871
Brantly-Hynes B2B and 305	106
Hiller FH-1100	62
Miller UH-12	370
Enstrom F-28 and F-280 series	453
Hughes/Schweizer 269 series	623
Hughes/McDonnell Douglas 369 series	615
Robinson R-22 series	296
Sikorsky S-55 and S-58*	172
Texas Helicopter M74L	**
Tomcat MK-5,6 series	**
Other Piston	91
TOTAL	3687

\* Outside Wt./Hp boundaries but included due to similarity of use.

\*\* Possibly included in 91 "other piston."

The mission profile for this group is shown in Figure 5.

Figure 5 depicts graphically the relative use of helicopters in this group for the missions shown, ranked below by use:

- |                       |  |
|-----------------------|--|
| 1. Aerial Application | 6. Instruction                         |
| 2. Business           | 7. Work                                |
| 3. Search and Rescue  | 8. Air Taxi                            |
| 4. Aerial Observation | 9. Other                               |
| 5. Personal           | 10. Commuter, EMS, Executive, Research |

Helicopters in this group flew an average of 318 hours in 1987 with an average trip time of 55 minutes. Table 9 shows the breakout of light utility group by engine type.

TABLE 9  
LIGHT UTILITY HELICOPTER STATISTICS  
Light Utility Group

Percent Twin Turbine	0
Percent Single Turbine	19.1
Percent Piston	80.9

#### 4.2.2.2 Light Turbine Group

This group consists of single and twin turbine helicopters ranging from 4,000 to 12,000 pounds gross weight and from 500 to 1,500 total take-off horsepower. The sample from the ASI database records contained data from 683 helicopters which was 20.9 percent of the ASI estimated active population of the light turbine helicopter group. Models in this group and the total estimated active population are shown in Table 10.

Figure 5  
LIGHT UTILITY HELICOPTERS  
MISSIONS FROM ASI DATABASE

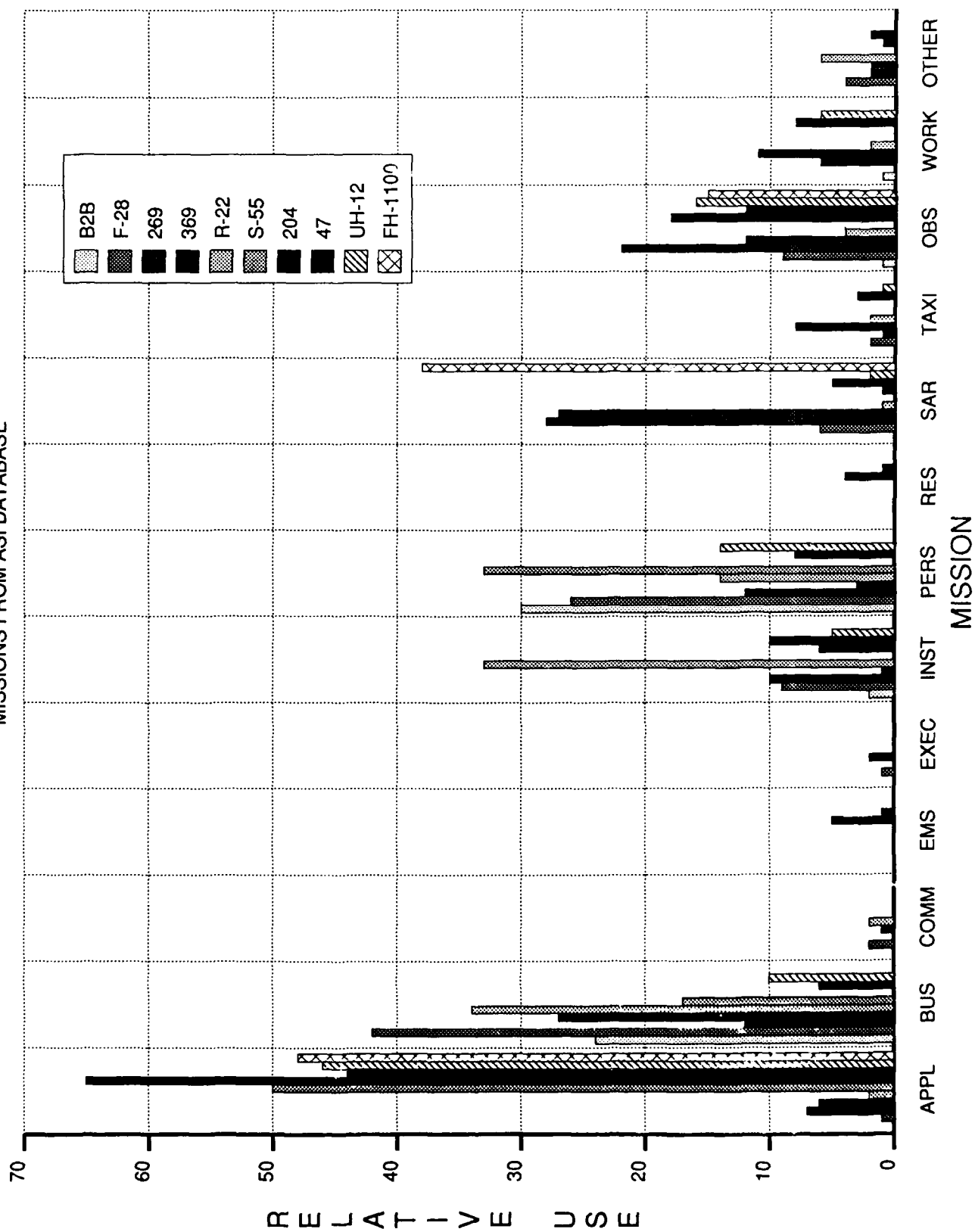


TABLE 10  
LIGHT TURBINE HELICOPTERS

Model	Estimated Active
Aerospatiale	
AS-316 series	41
AS-350 series	239
AS-341 series	36
AS-355 series	154
AS-360** series	0
AS-365 series	17
Agusta A-109	59
Bell	
206 and 206L series	1871
222	90
MBB	
BO-105	95
BK-117 series	64
Sikorsky S-76*	173
Other Turbine	<u>434</u>
TOTAL	3273

\* Outside Wt/Hp boundaries but included due to similarity of use.

\*\* This model not represented in ASI database sample.

Source: ASI Helicopter Forecasting Assessment.

Figure 6 indicates that while helicopters in this group were used for a variety of missions, EMS, air taxi, and business were predominant. Missions ranked by use were:

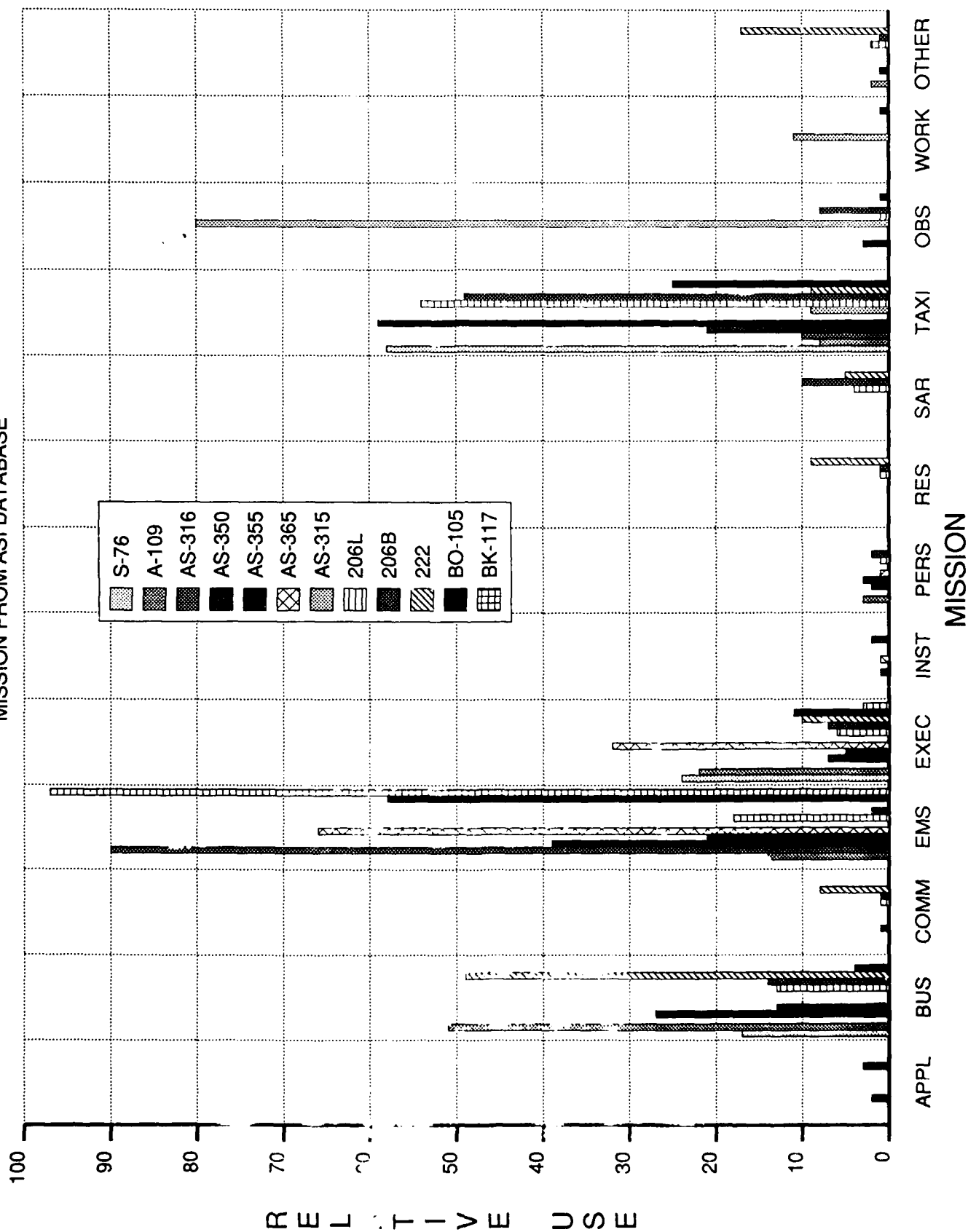
1. EMS
2. Air Taxi
3. Business
4. Executive
5. Search and Rescue
6. Other
7. Research
8. Commuter
9. Instruction, Personal, and Application

Helicopters in this group flew an average of 586 hours in 1987 with an average trip time of 33 minutes. Table 11 shows the breakout of the light turbine group by number of engines.

TABLE 11  
LIGHT TURBINE GROUP STATISTICS  
Light Turbine Group

Percent Twin Turbine	19.9
Percent Single Turbine	80.1
Percent Piston	0

Figure 6  
LIGHT TURBINE HELICOPTERS  
MISSION FROM ASI DATABASE



#### 4.2.2.3 Heavy Turbine Group

The heavy turbine group consisted of multiengine turbine helicopters ranging from 10,000 to 48,500 pounds gross weight and 1500 to 8150 takeoff horsepower. The sample data from the ASI database records contained data from 46 helicopters. Data on some helicopters in this group were obtained from discussions with commuter operators. Models considered in this group and the active population are shown in Table 12. Table 13 shows the breakout of the heavy turbine group by number of engines. Figure 7 depicts graphically the relative use of helicopters in this group for the missions shown, ranked below by use.

- |                      |                |
|----------------------|----------------|
| 1. Work              | 5. Other       |
| 2. Taxi              | 6. EMS         |
| 3. Commuter          | 7. Observation |
| 4. Search and Rescue |                |

The 46 helicopters in the sample studied consisted of 28.0 percent of the ASI estimated active population (ASI plus commuter operators) of the heavy turbine group. The average flight time per year for this group was 1265 hours with an average trip length of 74 minutes.

TABLE 12  
HEAVY TURBINE HELICOPTERS

<u>Model</u>	<u>Estimated Active</u>
Aerospatiale	
AS-320 **	0
AS-322 series **	0
Bell	
214 and 214B **	0
214ST	16
212	46
412	63
Boeing Vertol	
BV-107 ***	7
BV-234 ***	1
Sikorsky	
S-58T	26
S-70 **	0
S-61 ***	5
Westland W-30	0
TOTAL	164

\* Outside Wt/Hp boundaries but included due to similarity of use.

\*\* This model not represented in ASI database sample.

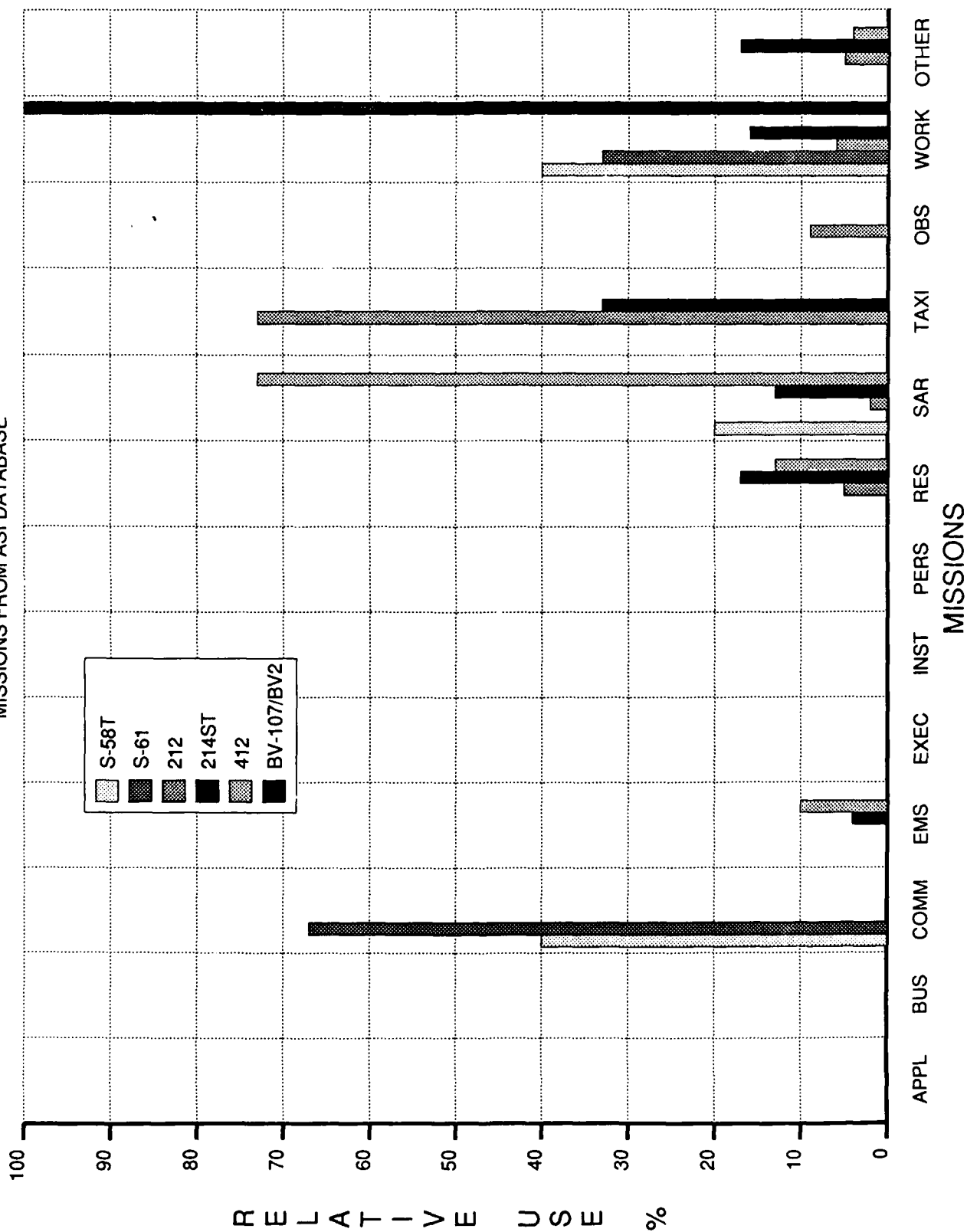
\*\*\* Active estimate increased based on discussions with current commuter operators.

Source: ASI Helicopter Forecasting Assessment.

TABLE 13  
HEAVY TURBINE GROUP STATISTICS  
Heavy Turbine Group

Percent Twin Turbine	100
Percent Single Turbine	0
Percent Piston	0

Figure 7  
HEAVY TURBINE HELICOPTERS  
MISSIONS FROM ASI DATABASE



#### 4.2.3 Helicopter Use Trends

The information in Table 14 was used to indicate which helicopter models are most likely to be used in given missions. The missions of interest to this study are EMS, Corporate/Executive, Scheduled Commuter, Search and Rescue and Offshore (Air Taxi). The corresponding mission data are compiled from the ASI database records and Hospital Aviation, July 1989.

TABLE 14  
HELICOPTERS FLOWN IN MISSION

	Scheduled Commuter	EMS	Business	Corporate Executive	Offshore or Air Taxi	Search and Rescue
Primary Use	S-61	B 206L BK 117 BO 105 AS 350	F28 R22 A 109 Bell 222 Hughes 369		S-76 AS 355 Bell 206 Bell 212 Bell 214 ST Bell 412	Hughes 269 Hughes 369
Secondary Use	S-58T	AS 355 AS 365 B 222 A 109 AS 316	Bell 206 B2B S-55 AS 350	A 109 S-76 AS 365 Bell 222 BK 117	BO 105	Bell UH-1 S-58 S-58T FH-1100

Source: ASI Database and Hospital Aviation, July 1989.

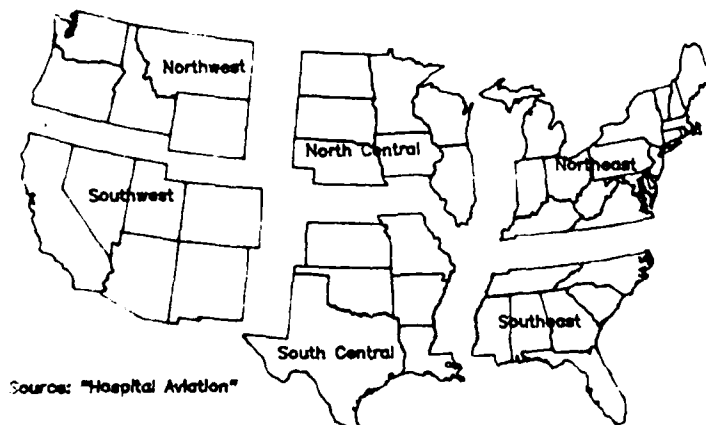
#### 4.3 MISSION OPERATIONAL CHARACTERISTICS

##### 4.3.1 EMS

EMS is the most heavily documented helicopter mission. Due to the efforts of the EMS industry itself, its growth and characteristics have been monitored in detail. Tables 15 through 18 present statistics regarding the operational characteristics of the EMS industry. Figure 8 presents the EMS data collection areas developed by Hospital Aviation as a basis for statistical analysis of the industry. Figures 9 through 11 depict the growth in the number of hospital-based EMS programs, the increase in the number of helicopters employed, and a history of the number of patient transports, respectively.

FIGURE 8

#### EMS STATISTICAL COLLECTION AREAS



Sources: "Hospital Aviation"

TABLE 15  
PRIOR YEAR COMPARISONS  
(Hospital-Based Helicopters)

Year	Average Annual Transports	Average Percent Scene	Average Percent Hospital	Average Percent Night	Average Miles One Way
1984	553	26%	64%	35%	61
1985	570	24%	64%	37%	63
1986	590	23%	67%	39%	61
1987	623	23%	68%	36%	61
1988	698	25%	70%	38%	61

Note: Does not add to 100 percent, tables presented as published.

Source: Hospital Aviation, March 1989.

TABLE 16  
TRANSPORTS BY AREA\*  
(Hospital-Based Helicopters)

Area	Number of Hospital Programs	Average Number of Transports	Average Percent to Scene	Average Percent to Sponsor	Average Percent at Night	Average Miles One Way
Northwest	14	554	29%	58%	31%	79 Miles
Southwest	19	898	47%	63%	39%	52 Miles
North Central	21	517	12%	62%	36%	67 Miles
South Central	30	702	24%	69%	40%	66 Miles
Northeast	35	756	20%	72%	39%	53 Miles
Southeast	37	694	25%	70%	38%	57 Miles
1988 Average		698	25%	70%	38%	61 Miles

\* Areas developed by Hospital Aviation, see Figure 8.

Note: Does not add to 100 percent, tables presented as published.

Source: Hospital Aviation, March 1989.

TABLE 17  
AEROMEDICAL PROGRAM STATISTICS  
GROWTH OF HOSPITAL-BASED HELICOPTER PROGRAMS

Year	Programs			Competing		Shared		Helicopters				Other	
	Start	Stop	Active	Prog %	Prog %	New	Add	Total	Cum	Twins%		Upgrade 'Copter	Change Oprtr
1972	2		2					2	2				
1973	0		2					0	2				
1974	0		2				1	1	3				
1975	1		3					1	4				
1976	1		4					1	5				
1977	1		5				1	2	7				
1978	7		12	2 17%	1 8%	7	1	8	15				
1979	14		26	4 15%	3 12%	14		14	29			1	3
1980	5		31	4 13%	3 10%	5		5	34	3%		3	2
1981	12		43	10 23%	6 14%	12	5	17	51	6%		6	3
1982	13	1	55	12 22%	7 13%	13	5	18	68	18%		9	2
1983	14		69	15 22%	10 14%	14	2	16	84	24%		11	7
1984	21		90	25 28%	14 16%	21	3	24	108	38%		12	9
1985	25	2	113	40 35%	20 18%	25	4	29	135	44%		8	7
1986	23		136	53 39%	23 17%	23	9	32	167	54%		15	11
1987	22	4	154	68 44%	23 15%	22	3	25	188	64%		NR	NR
1988	8	1	161	75 47%	23 14%	8	4	12	199	68%		NR	NR

NR - Data not reported.

Source: Howard Collett - Aviation Press.

TABLE 18  
MASTER AEROMEDICAL HELICOPTER PROGRAM STATISTICS

YEAR	HOSPITAL-BASED HELICOPTERS				NON-HOSPITAL-BASED		COMBINED	
	Active	Patient	Transports	Avg	Patient	Transports	Patient	Transports
	Programs	Annual	Cumulative		Annual	Cumulative	Annual	Cumulative
1972	2	203	203	102	1450	1450	1653	1653
1973	2	1416	1619	708	1800	3250	3216	4869
1974	2	1784	3403	892	2100	5350	3884	8753
1975	3	2183	5586	728	2300	7650	4483	13236
1976	4	2688	8274	672	2725	10375	5413	18649
1977	5	3571	11845	714	2975	13350	6546	25195
1978	12	6457	18302	538	3300	16650	9757	34952
1979	26	11866	30168	456	3825	20475	15691	50643
1980	31	17483	47651	564	4290	24765	21773	72416
1981	43	25013	72664	582	5055	29820	30068	102484
1982	55	32027	104691	582	6032	35852	38059	140543
1983	69	41097	145788	596	7291	43143	48388	188931
1984	90	51855	197643	576	7865	51008	59720	248651
1985	113	68694	266337	608	9331	60339	78025	326676
1986	136	87607	353944	644	10574	70913	98181	424857
1987	154	97900	451844	636	12300	83213	110200	535057
1988	161	108900	560744	676	12000	95213	120900	655957

Source: Howard Collett - Aviation Press.

FIGURE 9

# ACTIVE HOSPITAL-BASED EMS PROGRAMS

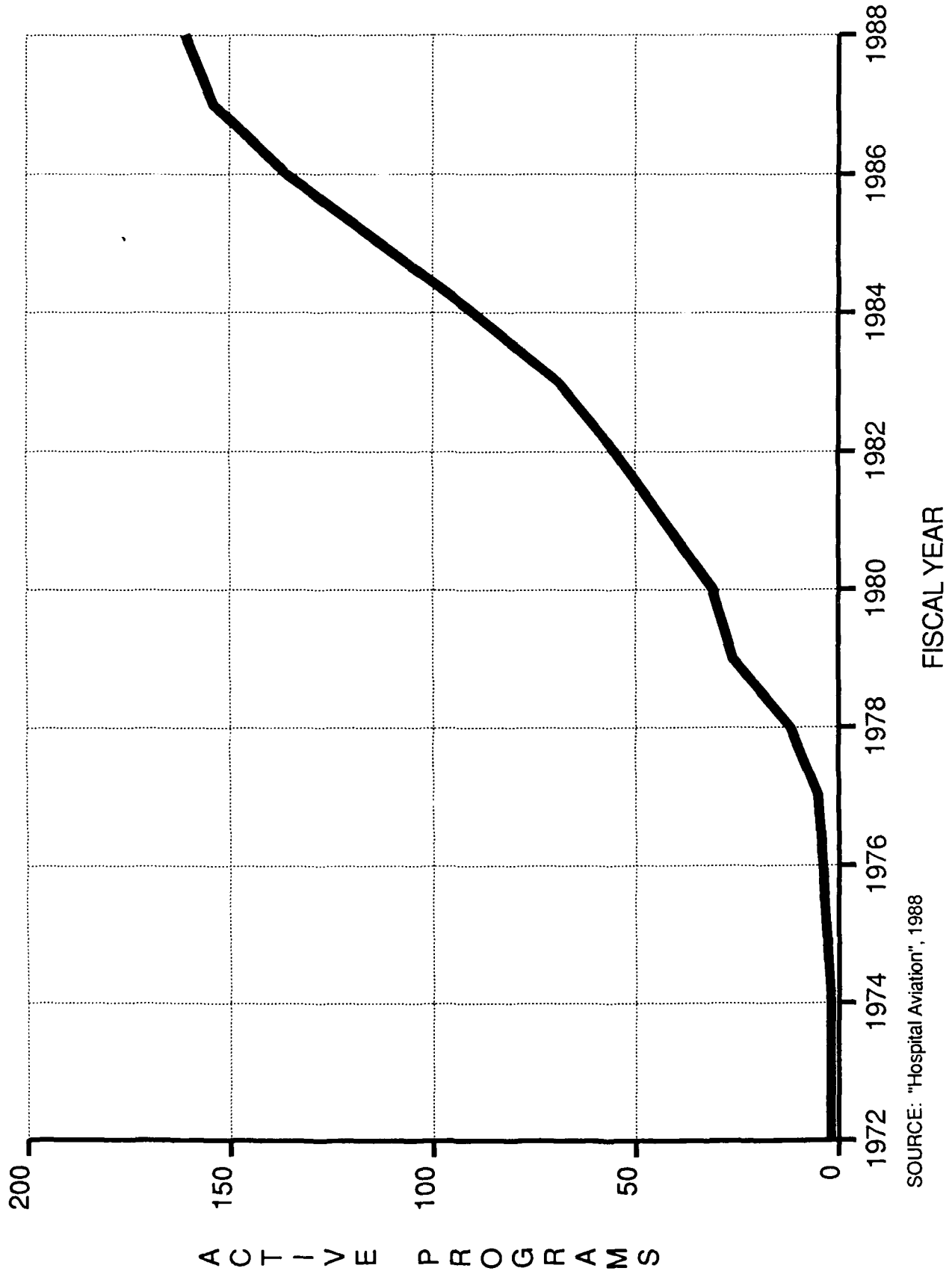
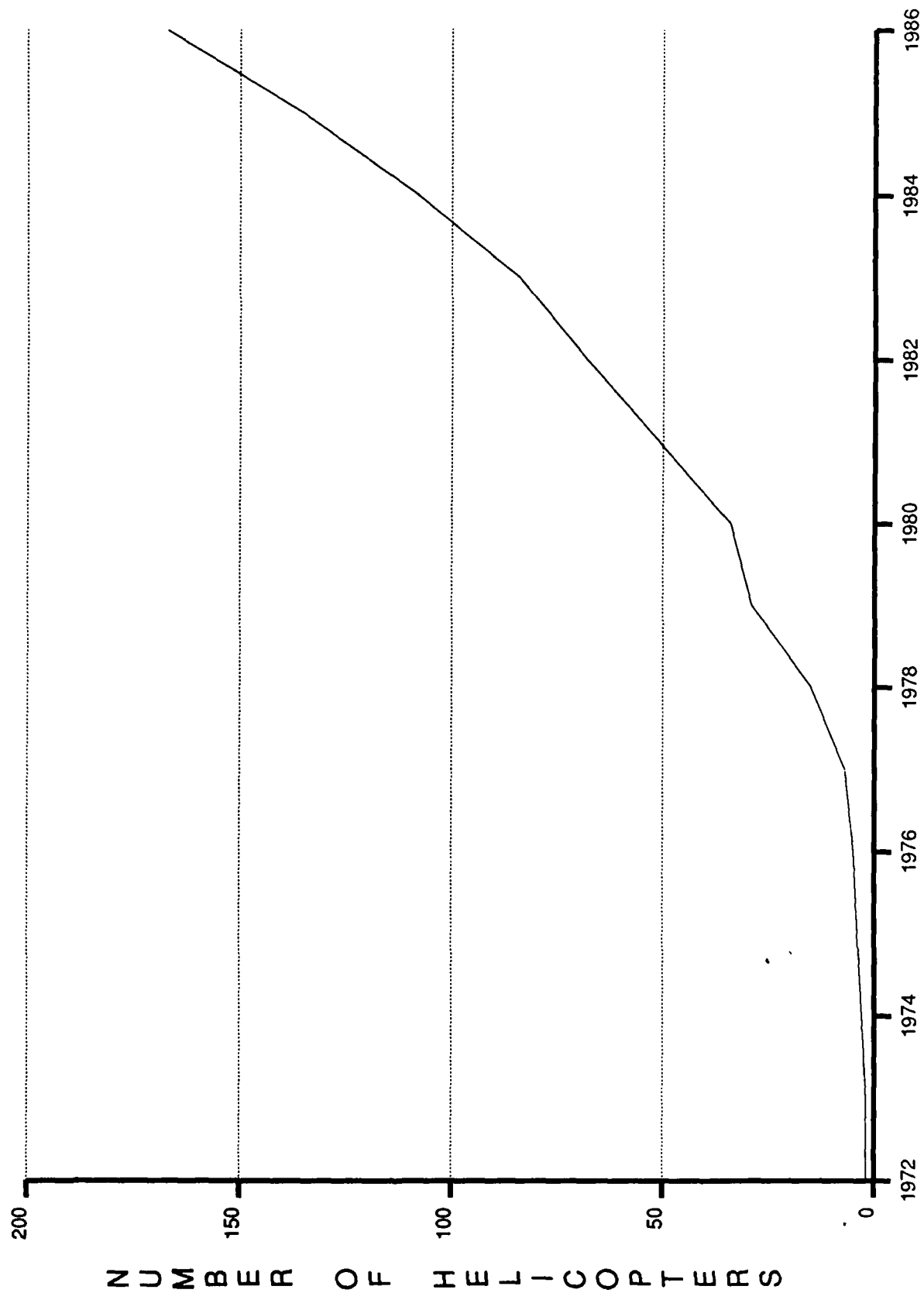


Figure 10  
**NUMBER OF HELICOPTERS IN HOSPITAL-BASED EMS**

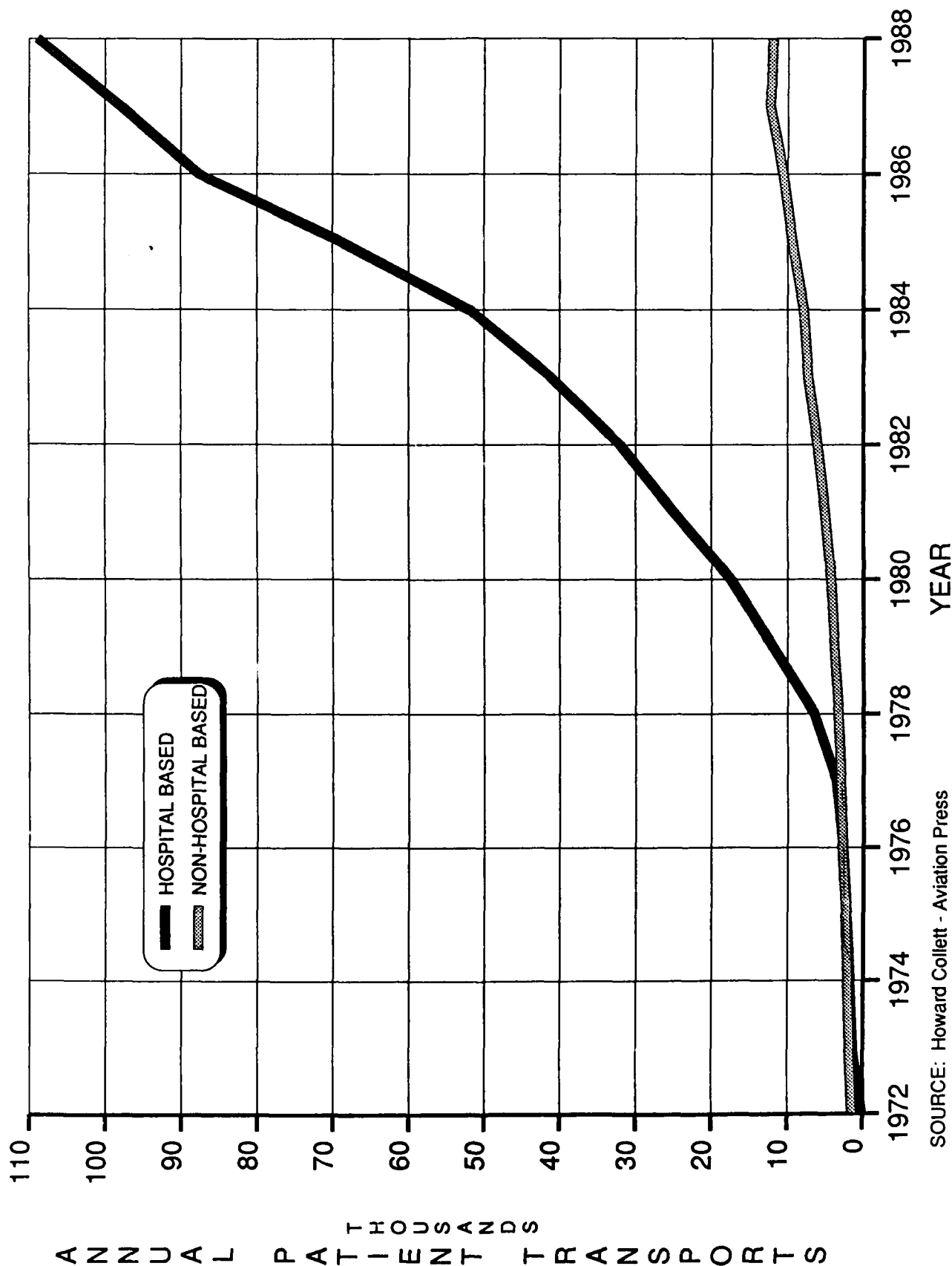


SOURCE: "Hospital Aviation", 1988.

FISCAL YEAR

# EMS PATIENT TRANSPORT HISTORY

FIGURE 11



SOURCE: Howard Collett - Aviation Press

Emergency medical service has been the fastest growing helicopter mission of the last decade. The first two EMS programs began in 1972. One new operator was added each year between 1975 and 1977. In 1978 seven new programs began and the trend continued. Both urban and rural areas employ helicopters to provide accident victim and patient transfer. Some states require that hospitals have heliports to be classified as trauma centers. Hospitals have recognized that helicopter services have increased their business share within the market area. Those patients transferred by helicopter are more likely to have health insurance, tend to stay longer at the hospital, and recommend the hospital to others. Because of this, several hospitals within the same area may institute EMS to stay competitive. Recent changes in Medicare payments have affected the profitability of EMS operations. This is one of a number of factors affecting the growth in the number of EMS operators.

#### 4.3.2 Corporate/Executive

The majority of corporate/executive operators own their own helicopters and operate under 14 CFR Part 91. In July 1988, the publishers of Rotor and Wing International completed a survey of 14 CFR Part 91 helicopter operators in the United States, Canada, and Asia. The results of this survey were published in R&WI Rotorcraft Report, Volume 2, Number 15, July 25, 1988. This survey provides a profile of the specific operational characteristics of Part 91 operators. Not all 14 CFR Part 91 operators are strictly corporate/executive but the results show that the majority of the operations (74 percent) carry personnel and the average trip length for executive transport is 20 minutes.

Corporate/executive activity was also analyzed for localities in the northeast using heliport systems studies. The heaviest concentration of this mission is located in the northeastern United States. Data is shown in Table 19 for Philadelphia, Boston, Downstate New York, and New Jersey. Downstate New York includes New York City, and the counties of Suffolk, Nassau, Rockland, Westchester, Putnam, Dutchess, Orange, Ulster and Sullivan.

TABLE 19  
CORPORATE/EXECUTIVE HELICOPTER ACTIVITY IN THE NORTHEASTERN UNITED STATES

<u>Locality</u>	<u>Percent Business/Corporate of Total Operations Within Locality</u>	<u>Percent Business/Corporate of Total Operations Into Locality</u>
Downstate New York	37%	N/A
Boston	65%	73%
Philadelphia	40%	52%
New Jersey	16%	N/A

N/A = Not Available

Source: Edwards & Kelcey, Philadelphia System Plan (1988), Boston System Plan (1988), New Jersey System Plan (1985), Downstate New York System Plan (1988).

#### 4.3.3 Scheduled Commuter

Scheduled commuter helicopter airlines have been operating since the early 1950's with varying success. These companies have always been located in major metropolitan areas (New York, Chicago, San Francisco-Oakland, Boston, Hartford, and Los Angeles). A subsidy became available from the Federal Government to helicopter airlines in 1947 when helicopters began carrying mail. The subsidy remained available until 1964. Interline agreements were often negotiated with commercial air carriers to provide funds to transport airline passengers using the helicopter service between city center locations and the airport. However, all of the original helicopter airlines eventually failed. This was due to several factors. Often a helicopter airline used too large a helicopter and continuously flew with low load factors. Early model passenger helicopters also had high operating costs and were less reliable than today's models. Limited IFR capability restricted all weather operations which made maintaining regular schedules difficult.

There are five scheduled commuter helicopter operations currently active in the United States. The following sections provide a summary of each of these operations.

##### 4.3.3.1 Trump Air (formerly Resorts International)

Trump Air provides transportation between the West 30th Street Heliport in New York City and the steel pier at Atlantic City, New Jersey. It operates three Sikorsky S-61 helicopters each having a capacity of 24 passengers. The average load factor is 65 percent. All three helicopters are IFR equipped and 20 percent of all flights are conducted under IFR. Trump Air is presently the only public scheduled commuter that operates IFR. The service makes three round trips per day starting at Trump's base at a public airport in Linden, New Jersey. It flies to the 30th Street Heliport in New York to pick up passengers, to Atlantic City to drop-off passengers, and returns to, Linden, New Jersey.

##### 4.3.3.2 New York Helicopters

New York Helicopters is based at the public use heliport at East 34th Street in New York City. It makes 18 round trips per day flying between 34th Street and Kennedy Airport. Most passengers are provided through interline agreements with major air carriers including those who have flown to the United States on the Concorde. New York Helicopters operates four Sikorsky S-58T helicopters that have 14 seats each and averages a 55 percent load factor. The helicopters are not IFR-equipped.

##### 4.3.3.3 Hub Express

Hub Express is a scheduled commuter operating in the Boston Metropolitan Area. The home base is Minute Man Airport in Stow, Massachusetts. Hub operates two helicopters, one Bell 206 Jet Ranger with five passenger seats and one Bell 206L Long Ranger with seven passenger seats. Hub makes 10 to 20 trips per day among 10 locations. Some of these stops are at airports, some at private or public use heliports. The primary destination is Boston Logan International Airport. Passengers are dropped off at an airline gate specified for helicopter use that is operated by Digital Equipment (see Section 4.3.3.4). The average load factor is 50 percent. The users of this commuter service

are persons willing to pay the \$20 per seat price. Its operational area is within or near Route 495 and Route 128. These highways are considered the boundaries of the immediate Boston suburban area. The helicopters are not IFR equipped.

#### 4.3.3.4 Digital Equipment Corporation (DEC)

DEC operates an "in-house" or private scheduled commuter service for its own employees. The operational base is located at Hanscom Field in Bedford, Massachusetts, a joint civil/military airport. DEC operates seven helicopters. Six are four-seat Bell 206 Jet Rangers, equipped for VFR only. The seventh is a fully IFR-equipped Bell 222-UT with eight seats. DEC makes an average of 60 trips per day with a load factor of 60 percent. The service is for the employees and customers of DEC only. The service area encompasses the company's branch locations throughout Massachusetts and New Hampshire. One primary destination is Boston Logan International Airport, where DEC leases its own airport gate (also used by Hub Express with DEC permission).

#### 4.3.3.5 Los Angeles Helicopters

Note: Los Angeles Helicopters was closed temporarily while its operation was reorganized. Because the survey was conducted during the reorganization, all information presented here is based on its original operation.

Los Angeles Helicopters is based on a parking structure heliport at Los Angeles International Airport (LAX). Los Angeles Helicopters operated two Aerospatiale A-Stars, each having six seats. They were not IFR-equipped. It plans to re-open with Bell 206 Jet Rangers. It operated with a load factor of 16-50 percent. Los Angeles Helicopters averages 14 trips from LAX to Burbank Airport and 13 from LAX to Long Beach Airport. The service was used by business executives and other passengers provided through interline agreements. The service area draws from the suburbs around Burbank and Long Beach in southern California.

#### 4.3.4 Offshore

The Helicopter Safety Advisory Conference (HSAC) takes a yearly survey of the offshore mission. Although each annual survey asks for slightly different data and not all questionnaires are returned, the results provide a good overview of offshore operations. The results of the past 5 year surveys are summarized in Table 20.

Offshore helicopter operations routinely fly between 100 and 160 miles one way offshore to oil rig helipads. It is anticipated that the rigs will be located as far as 200 miles offshore by the end of the century. At the present time there are an estimated 4,000 oil rigs in the Gulf of Mexico alone, 1,500 of them with helipads. There are two types of helicopter operators in the Gulf; oil companies that operate their own helicopters under 14 CFR Part 91, and companies who lease/rent helicopters from 14 CFR Part 135 operators.

TABLE 20  
GULF OF MEXICO  
OFFSHORE HELICOPTER OPERATORS

Year	Helicopter Fleet	SE	LT	MT	IFR Equipped	% IFR	Hours Flown	Annual Passengers
1984	882	N/A	N/A	N/A	N/A		685,560	5,990,448
1985	844	584	126	134	136	16%	719,304	5,602,140
1986	708	389	153	166	134	19%	691,655	4,241,762
1987	599	336	128	125	125	21%	455,330	2,792,435
1988	577	N/A	N/A	N/A	N/A	N/A	N/A	N/A

SE = Single Engine  
LT = Light Turbine Twin  
MT = Medium Turbine Twin  
N/A = Not Available

Source: Helicopter Safety Advisory Conference (HSAC) annual survey.

Although radar coverage is available at fixed-wing air carrier altitudes over the Gulf, there is no radar coverage beyond approximately 30 miles offshore at normal helicopter operating altitudes. Helicopters therefore operate VFR when flying to the rigs. The operators would like to fly IFR, not only because of the weather considerations, but to be afforded separation from other helicopters operating in the same environment. The current separation requirement for non-radar IFR operation in domestic airspace is 1,000 feet vertically and from five to twenty miles horizontally, depending on the speed differential of the aircraft in question. Separations of such magnitude do not permit the number of helicopters needed to accomplish the mission to fly at any one time. Additionally, beyond 100 miles, in international waters, the flight rules come under the authority of ICAO and the separation distances become even greater. Many operators navigate using Loran-C with each company tracking their own aircraft on a computer from the home base. In an emergency, operators cooperate with each other and share information between themselves and air traffic control facilities.

#### 4.3.5 Air Taxi/Commercial

Air taxi/commercial operations occur under 14 CFR Part 135. For the purpose of this analysis, the air taxi/commercial mission will be limited to on-demand charter for transportation of passengers or cargo not including support of offshore oil and gas production. Similarly, EMS operations conducted under 14 CFR Part 135 will be considered as EMS rather than air taxi/commercial. The remaining air taxi/commercial missions have many of the same operational characteristics as corporate/executive and business. These missions are flown in both urban and rural areas using helicopters ranging from single engine piston operating VFR thru IFR twin turbine. Mission concentration is located in the northeastern United States. Data is shown in Table 21 for Philadelphia, Boston, Downstate New York, and New Jersey.

TABLE 21  
AIR TAXI/COMMERCIAL HELICOPTER ACTIVITY IN THE NORTHEASTERN UNITED STATES

<u>Locality</u>	<u>Percent Air Taxi/Commercial of Total Operations Within Locality</u>	<u>Percent Air Taxi/Commercial of Total Operations Into Locality</u>
Downstate New York	38%	N/A
Boston	10%	5%
Philadelphia	25%	32%
New Jersey	27%	N/A

N/A = Not Available

Source: Edwards & Kelcey, Philadelphia System Plan (1988), Boston System Plan (1988), New Jersey System Plan (1985), Downstate New York System Plan (1988).

#### 4.3.6 Search and Rescue

Search and rescue missions are performed throughout the United States. Often the missions involve the cooperative efforts of local law enforcement, military, Civil Air Patrol and other government personnel. Typical rescue missions include evacuating victims of floods, fires, volcano eruptions, avalanches, earthquakes, and searching for lost, injured or ill persons and removing them from remote areas such as encountered while hiking, boating and mountaineering. Most missions involve operating in tight confines such as the high rise or congested urban environment or the opening to a stream surrounded by a heavy forest. Night operations are commonplace when involved in time critical evacuation missions.

#### 4.3.7 Business

There are few distinctions between business and corporate/executive operations. Helicopters are used in business for many reasons. These include the time saving or productivity increasing aspects of helicopter travel; aerial inspection of property, buildings, job sites, or operations; providing transportation for clients; providing transportation from business offices to airports; and providing increased security of personnel and information compared to public transportation. Many businesses or business owners own their own helicopters and operate under 14 CFR Part 91. Others fulfill their needs by chartering a helicopter and crew from a 14 CFR Part 135 operator.

As indicated previously (Table 14), helicopters from the light utility group are most often used for business. Business flights are typically short range with two-four passengers flown during normal working hours in day visual meteorological conditions (VMC).

#### 4.4. HELIPORTS/AIRPORTS PER MISSION

##### 4.4.1 EMS

Emergency medical services can save more lives and be more effective in reducing the long term effects of injuries if the receiving hospital has its own heliport. EMS operators can also be based at private heliports or, at a nearby airport. Figure 12 shows the location of EMS heliports taken from the Airport Master Record data files (FAA Forms 5010-1 and 5010-2).

##### 4.4.2 Corporate/Executive

Although some corporate users may have heliports at their headquarters, branch offices, or both, most of these heliports do not have fuel and maintenance facilities. The helicopters are often based at a nearby airport with company heliports used only to pick up and drop off passengers and cargo.

One of the biggest complaints that corporate/executive helicopter operators have is the lack of available heliports. They would prefer to have heliports as close to their final destinations as possible. They believe the lack of public use, urban and corporate heliports constrains the effectiveness of the helicopter for corporate/executive use.

##### 4.4.3 Scheduled Commuter

The type of landing site that scheduled commuter operations use varies from major international airports, such as Los Angeles International and Boston Logan, to small privately owned facilities in outlying urban areas and at some hotels along their flight routes.

Airports provide full service facilities for scheduled commuter helicopters, while small private heliports often provide only a landing site. The homebases of all the currently active scheduled commuter services are located at airports.

##### 4.4.4 Offshore

There are 273 heliports in 33 localities that support the offshore oil industry. These are listed in Table 22 and are depicted graphically in Figure 13. The majority of these heliports are private use, operated exclusively in support of oil industry helicopters. Many area airports also serve as helicopter bases.

##### 4.4.5 Air Taxi/Commercial

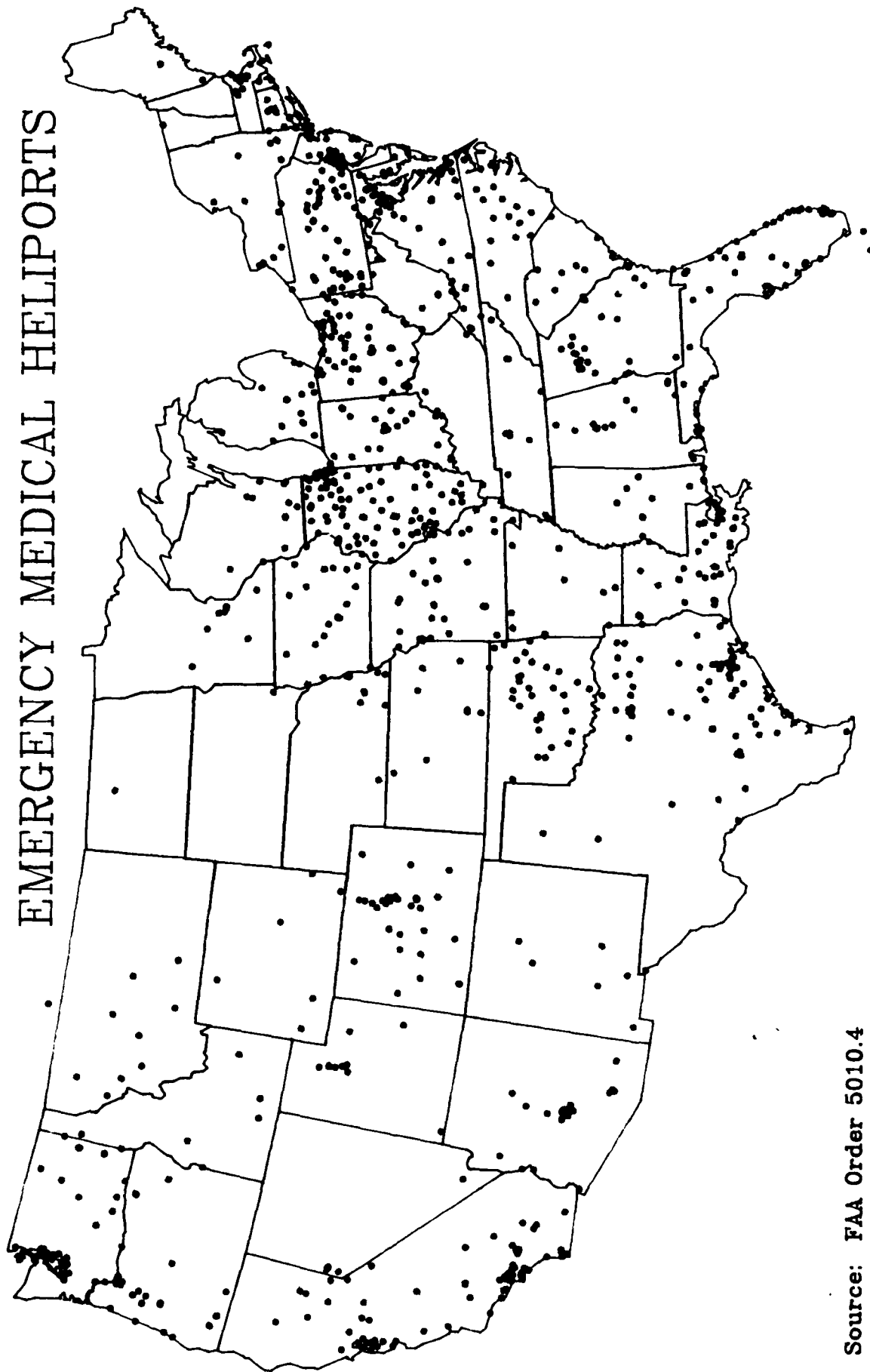
Most air taxi/commercial operations are based at airports in order to have access to fuel and maintenance facilities. Figure 14 indicates the current locations of 14 CFR Part 135 helicopter operators.

##### 4.4.6 Search and Rescue

The base heliports used by helicopters involved in search and rescue are, for the most part, those which law enforcement agencies and sheriff's departments use. Currently there is a survey being conducted by the Airborne Law Enforcement Association which will specify all heliports used by their 335 member agencies.

Figure 12

# DISTRIBUTION OF U.S. EMERGENCY MEDICAL HELIPORTS



Source: FAA Order 5010.4

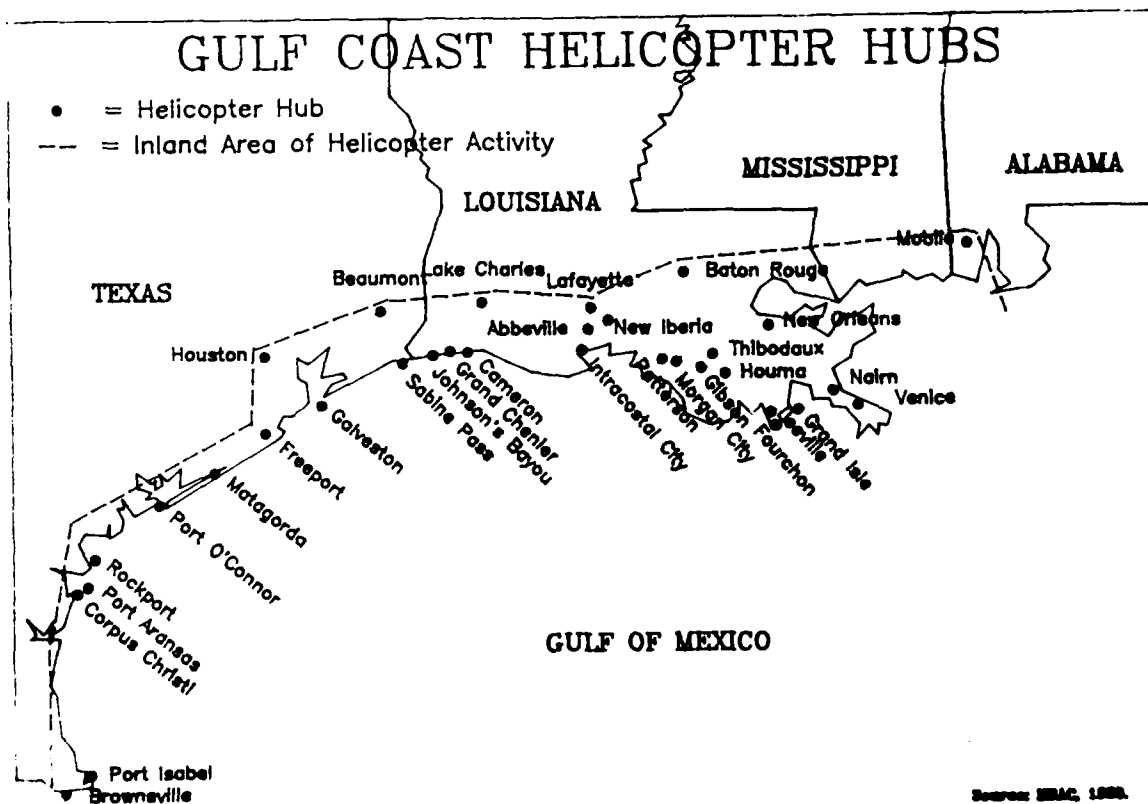
TABLE 22  
GULF OF MEXICO HELICOPTER HUBS/HELIPORTS

Locality	Heliports	Locality	Heliports
Johnson's Bayou, LA	4	New Orleans, LA*	18
Nairn, LA	2	Venice, LA	11
Houma, LA*	8	Baton Rouge *	1
Thibodeaux, LA	1	Leeville, LA	1
Grand Isle, LA	4	Fourchon, LA	8
Gibson, LA	1	Morgan City, LA	16
Patterson, LA*	2	New Iberia, LA*	2
Lafayette, LA*	12	Abbeville, LA	3
Intracoastal City, LA	12	Lake Charles, LA*	14
Grand Chenier, LA	5	Cameron, LA	11
Port Aransas, TX	1	Sabine Pass, TX	12
Beaumont, TX	5	Houston, TX*	52
Galveston, TX*	14	Freeport, TX*	10
Matagorda, TX	6	Port O'Connor, TX	8
Rockport, TX*	11	Corpus Christi, TX*	7
Port Isabel, TX	3	Brownsville, TX*	4
Mobile, AL*	4		

\* Includes local airport as a landing site.

Source: HSAC

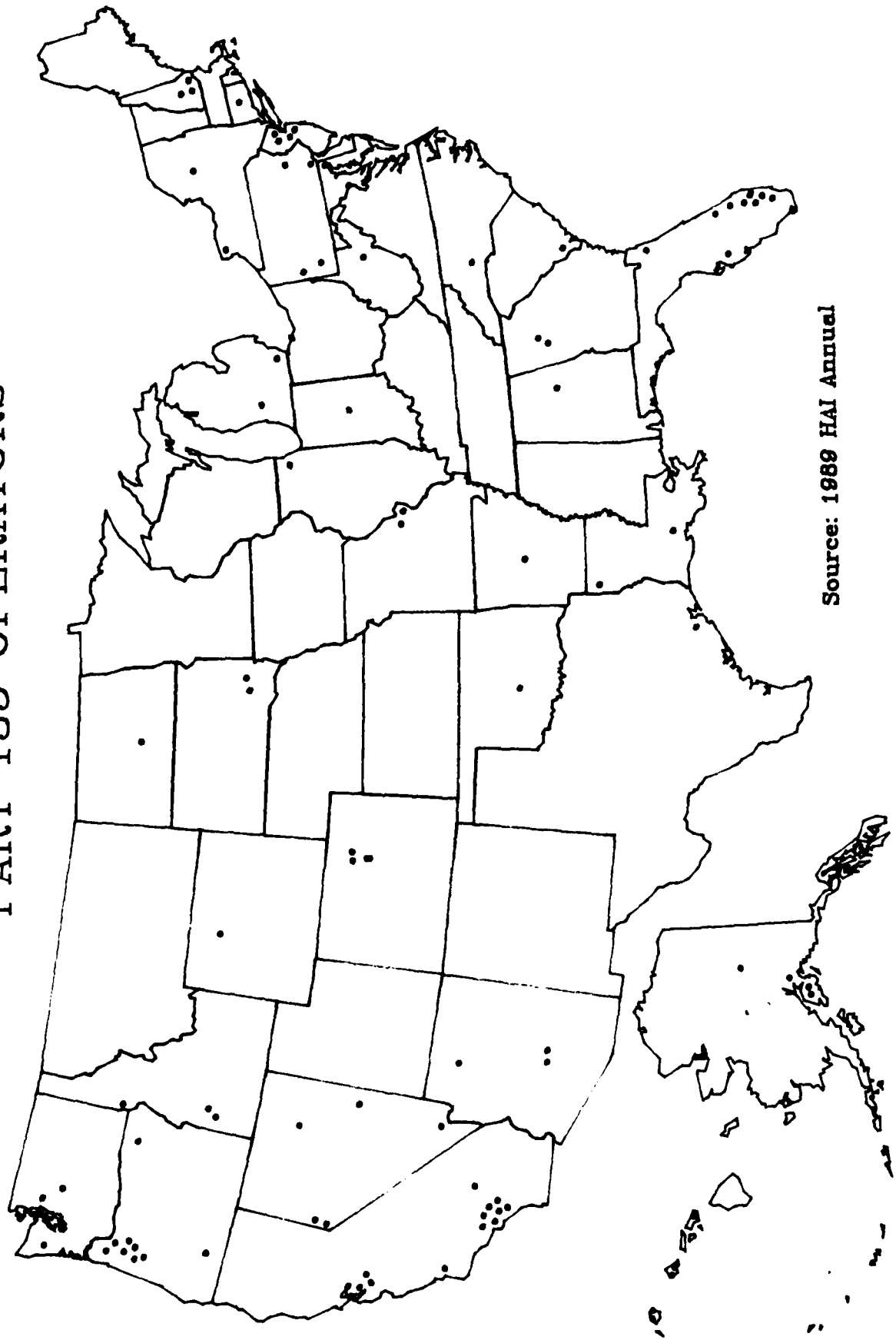
FIGURE 13



Source: HSAC, 1980.

FIGURE 14

# PART 135 OPERATORS



Source: 1989 HAI Annual

#### 4.4.7 Business

Most business helicopters used by either 14 CFR Part 91 or Part 135 operators are based at airports. Private heliports, parking lots, or suitable portions of company property are used at business office and outlying facilities. Many business operators would take advantage of public urban heliports if they were available. Some business operators find basing at airports advantageous to allow quick transfer between airplane and helicopter for flights to the business office.

#### 4.5 MISSION ROUTE STRUCTURES

##### 4.5.1 EMS

The vast majority of emergency medical helicopter services fly strictly VFR. In a survey conducted by Systems Control Technology, Inc. and Howard Collett of Hospital Aviation magazine, of the 30 operators responding, only three stated that they flew any IFR operations. Of those, one flew IFR 5 percent of the time with one of their two helicopters. The second flew IFR 5 to 8 percent of the time depending on the helicopter being used, and the third said they flew IFR 30 percent of the time.

An EMS operator can operate from the base hospital to a referral hospital and return, from the base hospital to an accident scene and return, or from the base hospital, to the scene, to the referral hospital, and return. An EMS operator located at a base other than a hospital makes the same type of trips but must add another leg on to the total trip. The majority of hospital-based helicopters must fly to nearby airports for fuel and maintenance.

##### 4.5.2 Corporate/Executive

Corporate/executive operations are variable and flexible. The altitudes flown and whether the operation will be VFR or IFR depends on the location of the corporate operator in the United States, what industry the helicopter is supporting, and its local origin and destination. Corporate/executive operations are primarily flown VFR.

The only area where there is considerable use of IFR for helicopter operations is in the northeast corridor, especially in the Boston and New York City regions. This is due primarily to the extensive area covered by controlled airspace, the concentration of the larger more fully equipped helicopters and to the higher probability of IMC.

There are, however, some problems with IFR helicopter operation in this region. Operators complain of the lack of access to established routes, excessive ATC delays, and lack of air traffic controller familiarity with helicopter capabilities which results in being forced to "fly like a fixed-wing" aircraft when it is not necessary or desirable. These factors limit the effectiveness of helicopter transportation for the corporate/executive mission.

#### 4.5.3 Scheduled Commuter

##### 4.5.3.1 Trump Air

All Trump Air helicopters are IFR equipped and 20 percent of all flights are operated under IFR. Figure 15 shows the generalized structure of Trump Air's routes. The service makes three round trips per day from Trump's base at a public airport in Linden, New Jersey. Trump flies IFR routes according to an established route structure developed with the FAA.

##### 4.5.3.2 New York Helicopters

New York Helicopters aircraft are not IFR equipped. The operator feels that to fly IFR would take "three or four times as long", given the current delays in the New York City area. New York Helicopters operates, by Letter of Agreement, on a route structure developed with local FAA authorities. Figure 16 shows the route used by New York Helicopters.

##### 4.5.3.3 Hub Express

Hub Express helicopters are not IFR equipped. The route structures in use are established by Letter of Agreement with local FAA authorities. Figure 17 depicts the generalized Hub Express route structure.

##### 4.5.3.4 Digital Equipment Corporation (DEC)

Digital Equipment Corporation has established a route structure within the Boston TCA and their own IFR route for the Bell 222 UT, through a Letter of Agreement with the local FAA authorities. Figure 18 presents a generalized pattern of DEC routes.

##### 4.5.3.5 Los Angeles Helicopters

Los Angeles Helicopters has established routes by Letter of Agreement with the local FAA authority. They fly directly from LAX to Burbank or to Long Beach. None of the helicopters are IFR equipped and the company feels there would be little advantage to IFR operations since weather occurrences necessitating IFR operation are rare. Figure 19 shows a generalized route pattern.

#### 4.5.4 Offshore

The highest concentration of offshore helicopter support to the petroleum and natural gas industries is over the Gulf of Mexico with inland support areas located in a narrow band along the gulf coast. The helicopter operational system in the Gulf of Mexico region is VFR. However, for operations out over the water most operators would prefer to be able to fly IFR. Offshore helicopter IFR routes and en route descent areas are shown in Figure 20. At the present time efficient IFR flight is not possible because of the lack of radar coverage. Non-radar IFR separation requirements are too restrictive for high density helicopter operations.

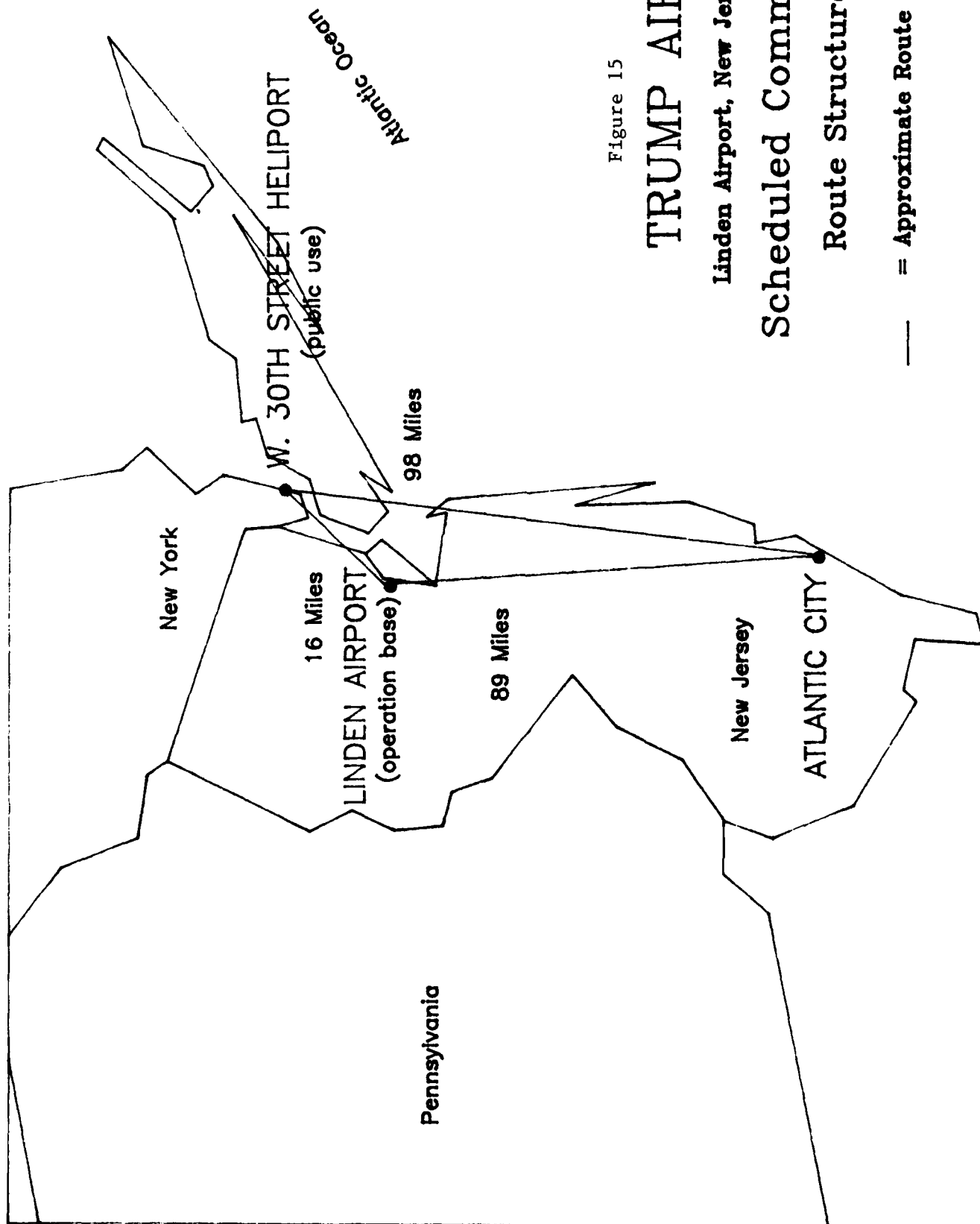


Figure 15

## TRUMP AIR

Linden Airport, New Jersey

Scheduled Commuter

Route Structure

— = Approximate Route Structure

Figure 16

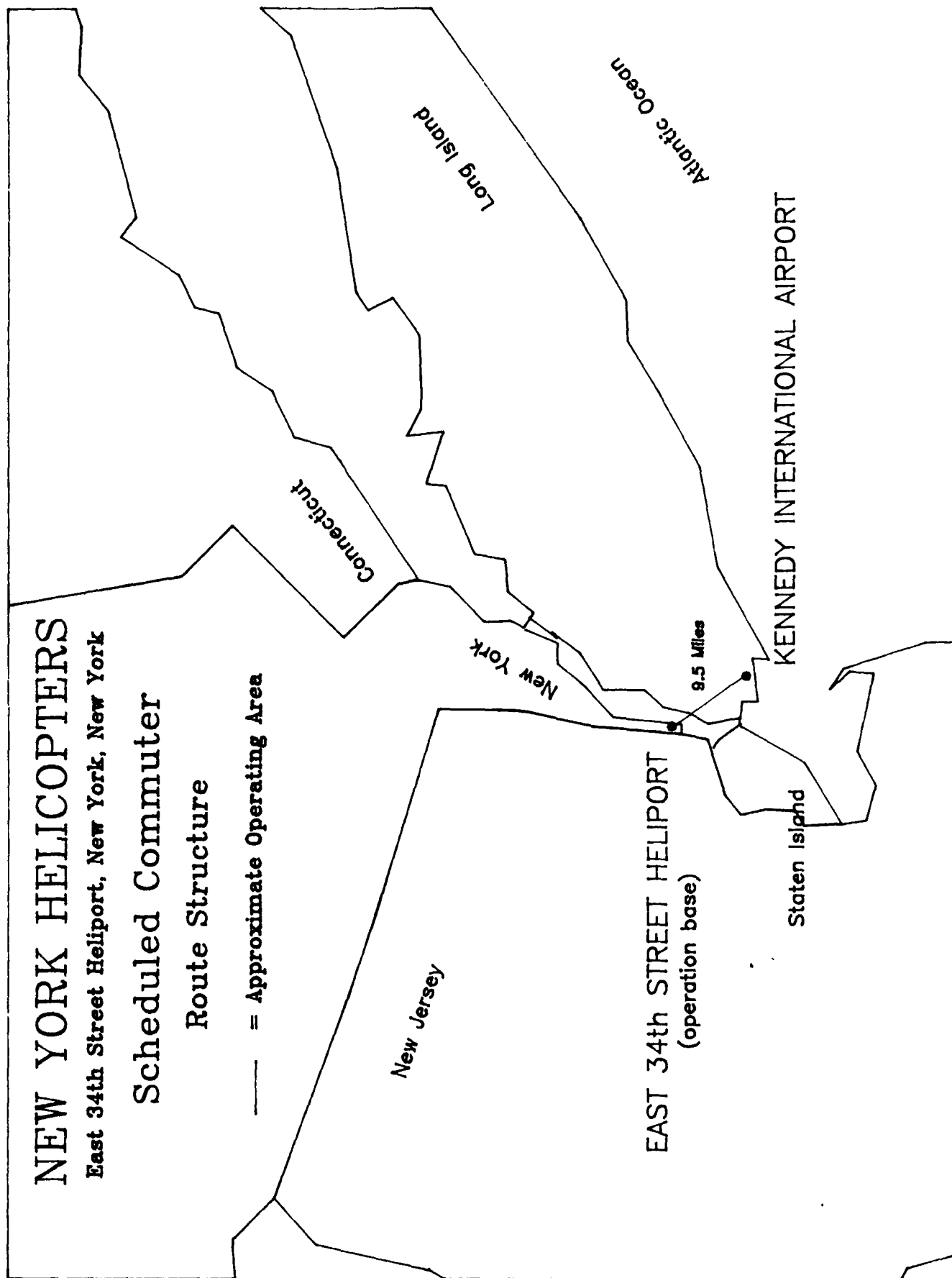


FIGURE 17

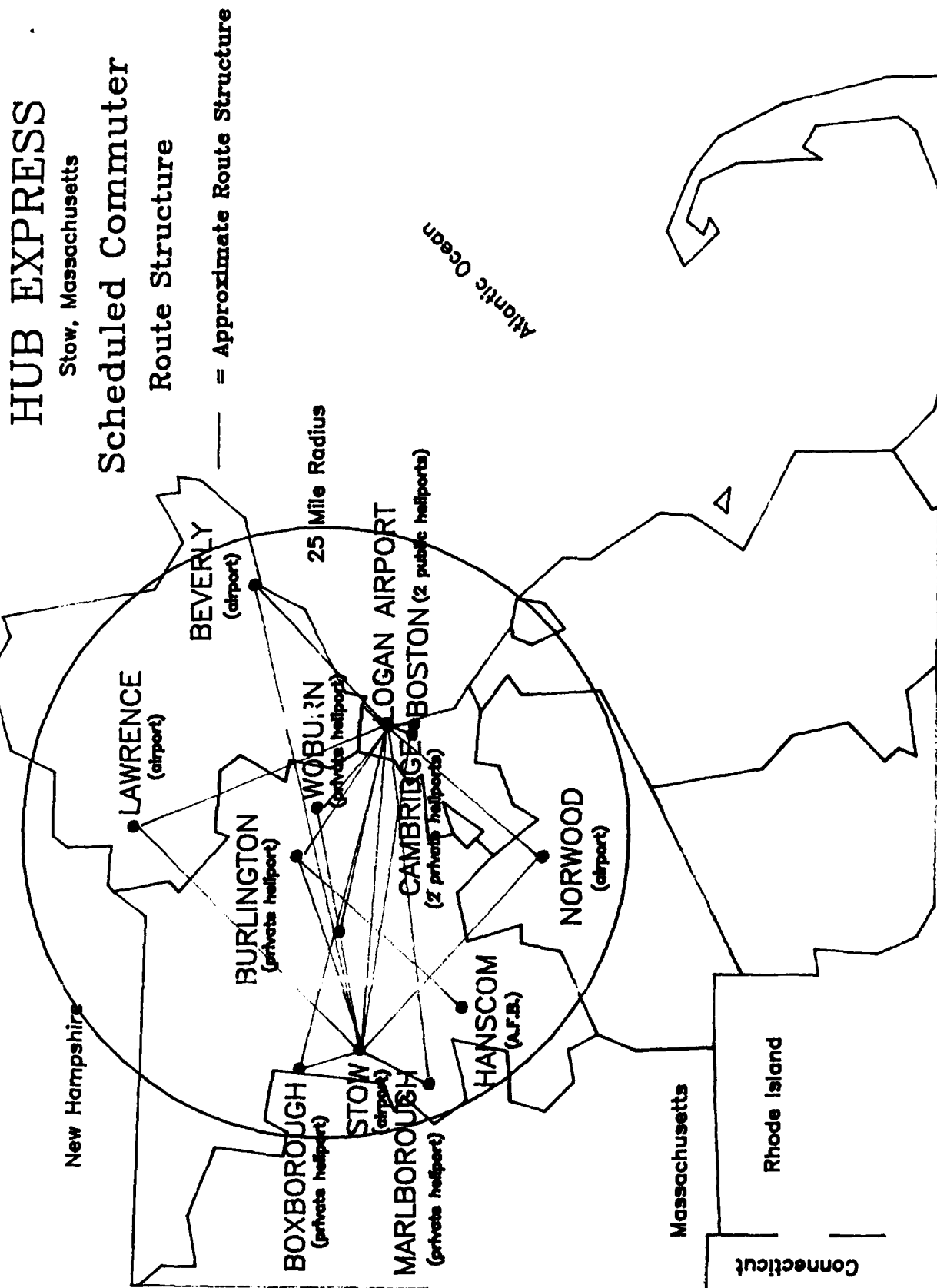


Figure 18

# DIGITAL EQUIPMENT

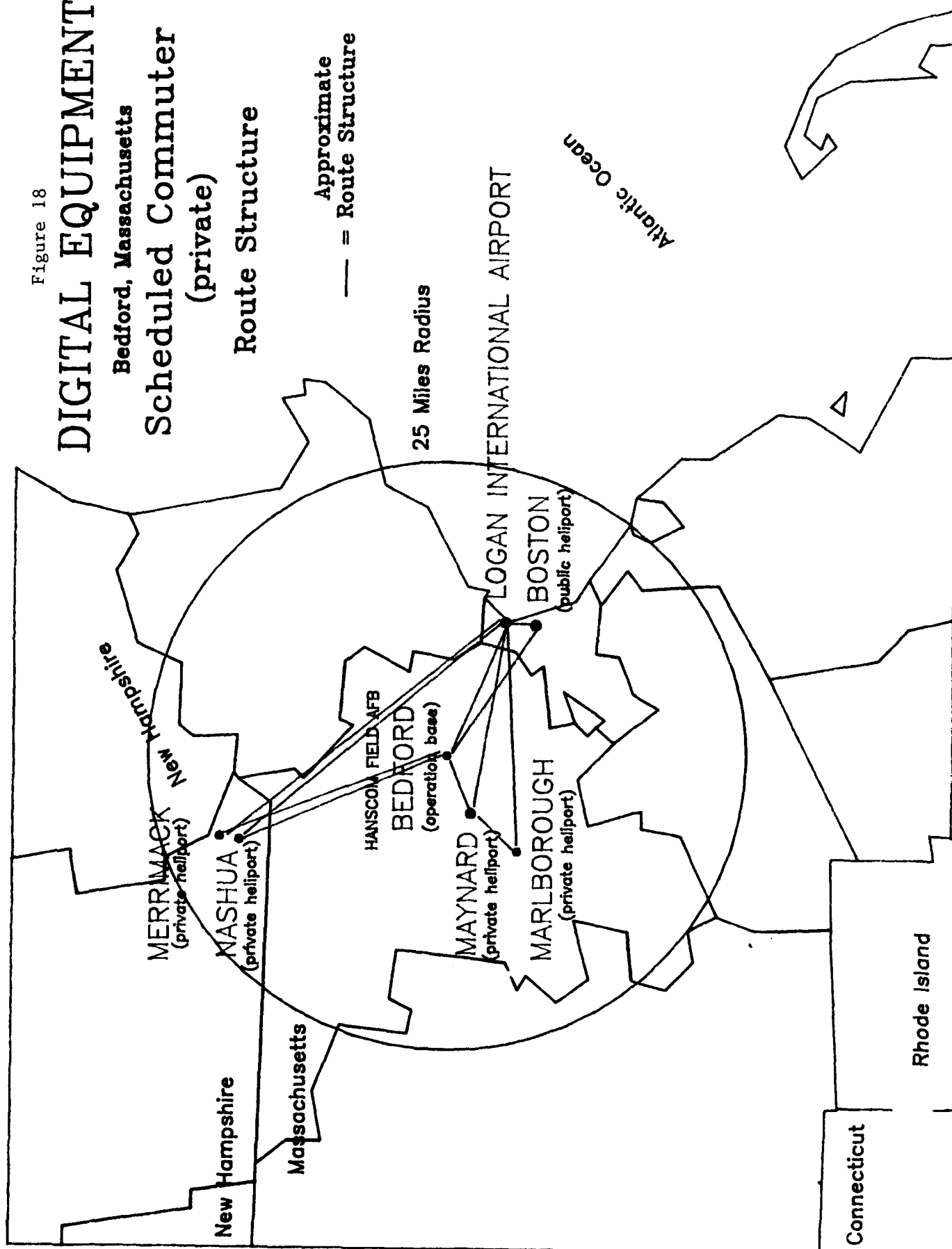
Bedford, Massachusetts

Scheduled Commuter  
(private)

Route Structure

Approximate  
— = Route Structure

25 Miles Radius



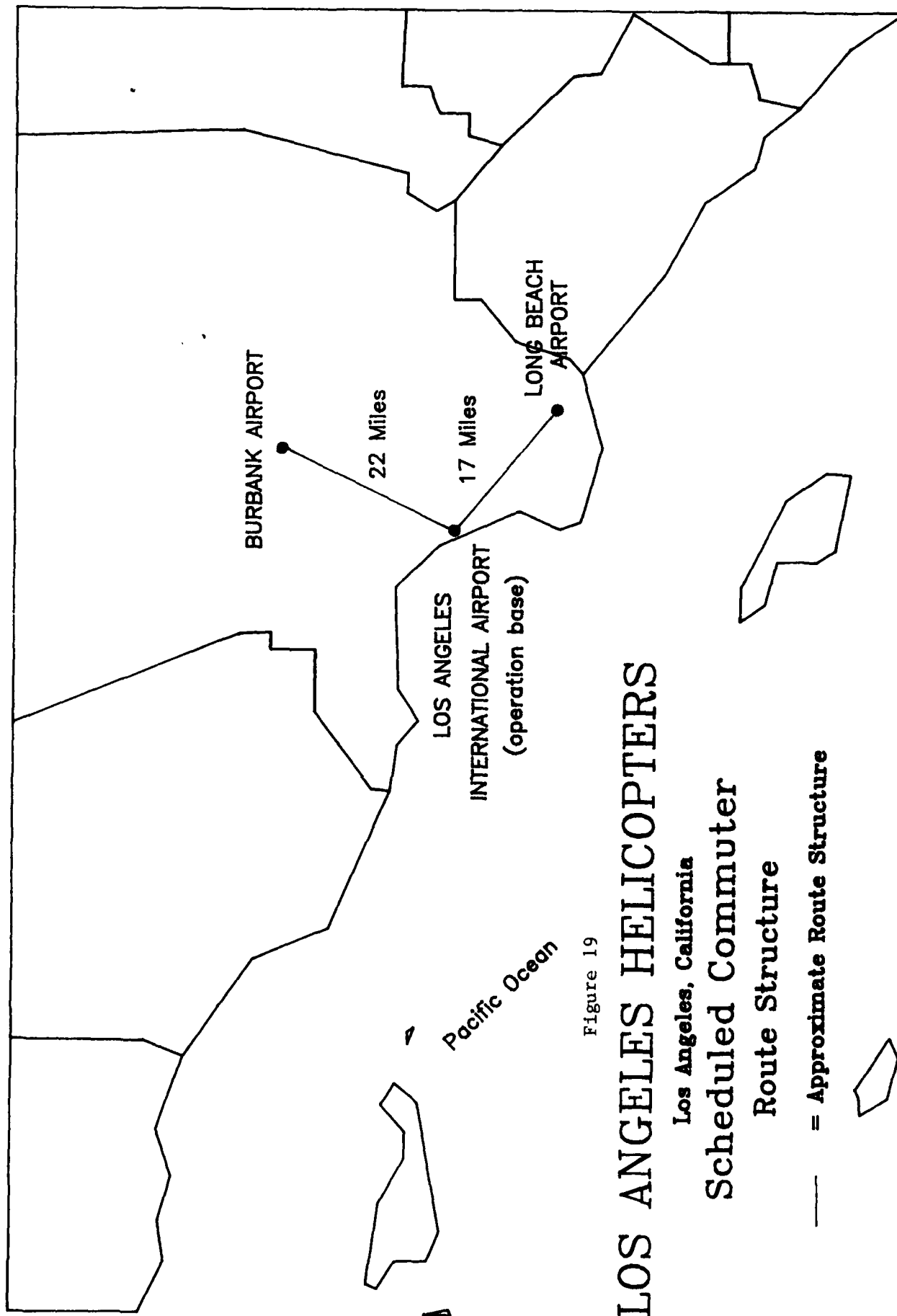


Figure 19

# LOS ANGELES HELICOPTERS

Los Angeles, California

Scheduled Commuter

Route Structure

— = Approximate Route Structure

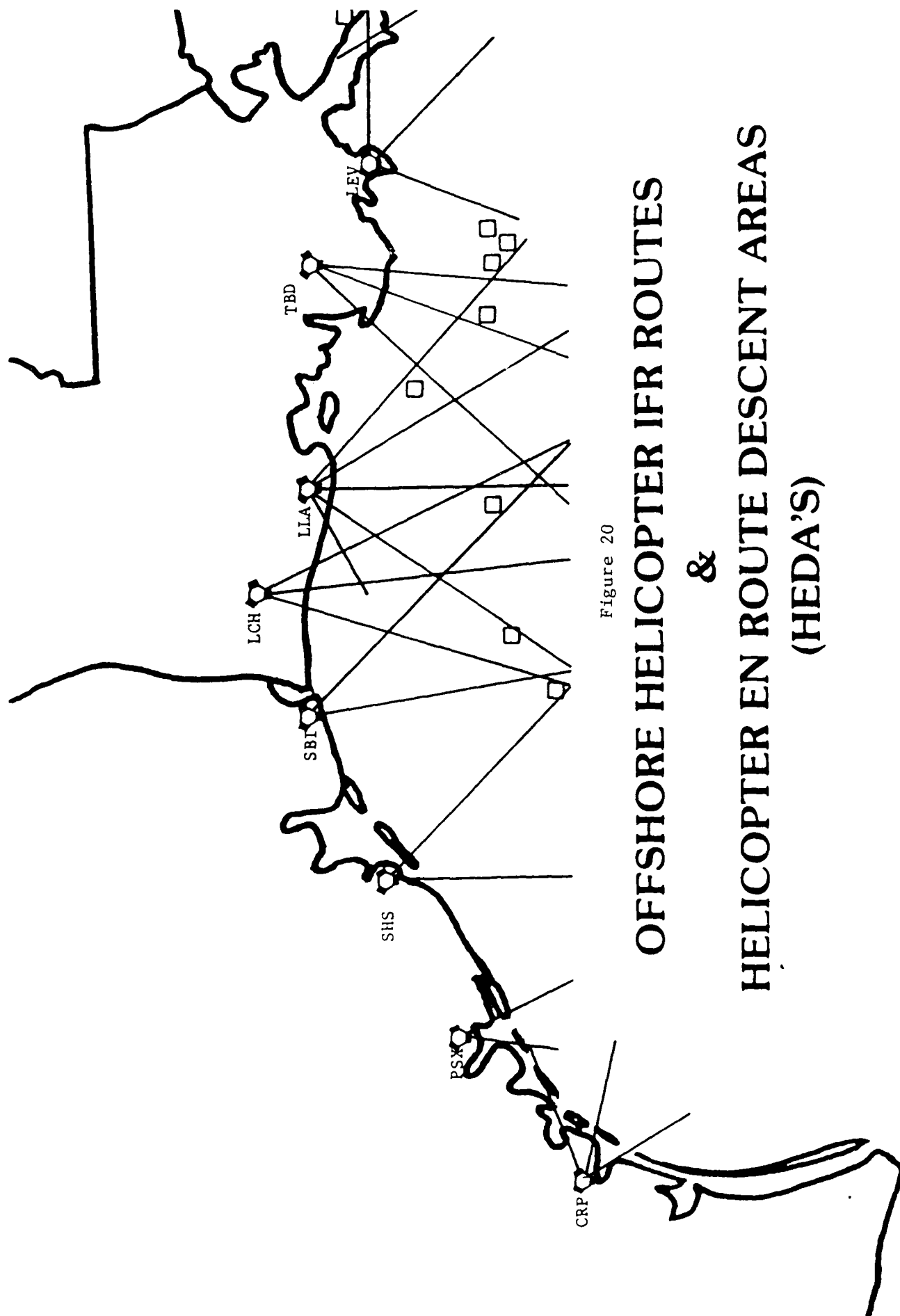


Figure 20

# OFFSHORE HELICOPTER IFR ROUTES & HELICOPTER EN ROUTE DESCENT AREAS (HEDA'S)

Source: Offshore Logistics, Inc., Lafayette, LA, January 20, 1984

#### 4.5.5 Air Taxi/Commercial

Specific routes for air taxi/commercial missions have not been identified but are needed to support viable schedules and essential IFR operations. Air taxi operators in urban areas with charted VFR helicopter routes such as Washington, D.C., New York, Los Angeles, and Chicago have taken advantage of these routings.

#### 4.5.6 Search and Rescue

No established routes exist for search and rescue operations as the routes flown vary widely with individual mission constraints and conditions. If an operator repeatedly flies search and rescue missions to a particular location, such as a national park area, special routes or procedures may be developed based on the terrain and weather conditions.

#### 4.5.7 Business

Business operations, like corporate/executive, are variable and flexible. If repetitive flights between certain destinations are made, individual business operators may fly on specific routes established by Letter of Agreement with local ATC facilities. Other businesses may use charted VFR routes such as those in the Washington, D.C., New York, Los Angeles, and Chicago areas. Business helicopters fly either VFR or IFR depending on equipage and pilot training.

### 4.6 HELICOPTER ACCIDENT DATA

Statistical rotorcraft accident data are available from various sources including insurance companies, the National Transportation Safety Board, the Flight Safety Foundation, helicopter and engine manufacturers, various operator groups, and industries and associations that use, track, or employ rotorcraft. This section describes and reviews the helicopter accident data available.

#### 4.6.1 National Transportation Safety Board

The National Transportation Safety Board (NTSB) maintains a comprehensive database of aircraft accidents covering the periods from 1982 through 1987. As accident case files are closed, the pertinent data is added to the comprehensive database. Less detailed accident data is contained in the database back to 1961. The NTSB publishes an Annual Review of Aircraft Accident Data - General Aviation that presents a statistical compilation and review of general aviation accidents occurring over the year reviewed. The date of publication is usually 2 years after the period covered by the report. The data does not include accidents that occurred while conducting operations under 14 CFR Parts 121, 125, 127 or 135. These accidents are contained in a separate report, Annual Review of Aircraft Accident Data - U.S. Air Carrier Operations.

Tables 23, 24, and 25 list accident data for rotorcraft operating under 14 CFR Part 91 from 1977 to 1986. Tables 24 and 25 represent reciprocating engine and turbine-powered rotorcraft accident data respectively. These data show a trend of accident rate decrease for all rotorcraft and those with reciprocating engines, but show a leveling-off for the turbine-powered accident rate. NTSB also presents accident rates by kind of flying (i.e., personal and business, corporate/executive, aerial application, instruction etc.), but does not sort by type of aircraft (fixed-wing vs rotorcraft). In addition, the degree of injury of persons aboard rotorcraft involved in accidents is also listed by kind of flying.

TABLE 23  
ACCIDENTS, HOURS, AND ACCIDENT RATES  
ALL ROTORCRAFT: 1977 - 1986

YEAR	ACCIDENTS	HOURS FLOWN	ACCIDENT RATE PER 100,000
			AIRCRAFT HOURS FLOWN
1977	246	1,170,000	21.03
1978	283	1,397,000	20.26
1979	265	1,522,000	17.41
1980	261	1,891,000	13.80
1981	257	2,303,000	11.16
1982	255	1,628,000	15.60
1983	238	1,709,000	13.93
1984	224	1,599,000	14.01
1985	206	1,706,000	12.08
1986	191	1,689,000	11.31

Source: NTSB Annual Review of Aircraft Accident Data, 1986.

TABLE 24  
ACCIDENTS, HOURS, AND ACCIDENT RATES  
ROTORCRAFT - RECIPROCATING ENGINE: 1977 - 1986

YEAR	ACCIDENTS	HOURS FLOWN	ACCIDENT RATE PER 100,000
			AIRCRAFT HOURS FLOWN
1977	190	571,000	33.27
1978	223	766,000	29.11
1979	185	859,000	21.54
1980	181	719,000	25.17
1981	178	878,000	20.27
1982	157	570,000	27.37
1983	143	566,000	25.27
1984	128	578,000	22.15
1985	119	557,000	21.36
1986	118	789,000	14.96

Source: NTSB Annual Review of Aircraft Accident Data, 1986.

TABLE 25  
ACCIDENTS, HOURS, AND ACCIDENT RATES  
ROTORCRAFT - TURBINE POWERED: 1977 - 1986

<u>YEAR</u>	<u>ACCIDENTS</u>	<u>HOURS FLOWN</u>	<u>ACCIDENT RATE PER 100,000 AIRCRAFT HOURS FLOWN</u>
1977	56	599,000	9.35
1978	60	631,000	9.51
1979	80	663,000	12.07
1980	80	1,172,000	6.83
1981	79	1,424,000	5.55
1982	98	1,061,000	9.24
1983	95	1,143,000	8.31
1984	96	1,021,000	9.40
1985	87	1,149,000	7.57
1986	73	900,000	8.11

Source: NTSB Annual Review of Aircraft Accident Data - General Aviation, 1986.

NTSB's Annual Review of Aircraft Accident Data reports are useful for determining the total number of rotorcraft accidents, but do not reveal any mission-related information.

A Special Study - Review of Rotorcraft Accidents, 1977-1979 by the NTSB illustrates rotorcraft accident rates by kinds of flying. Table 26 shows data for accidents occurring between 1977 and 1979. Figure 21, taken from DOT/FAA/PM-86/45, Aeronautical Decision Making for Helicopter Pilots, prepared by Systems Control Technology, Inc., illustrates graphically the distribution of the data. The combined number of "aerial observation" and "others" accidents in Figure 21 total to the "other" category amount listed in Table 26. This figure shows that the greatest number of rotorcraft accidents during the timeframe of 1977-1979 occurred while performing aerial applications and personal business.

TABLE 26  
ROTORCRAFT ACCIDENT RATES BY KINDS OF FLYING: 1977 - 1979

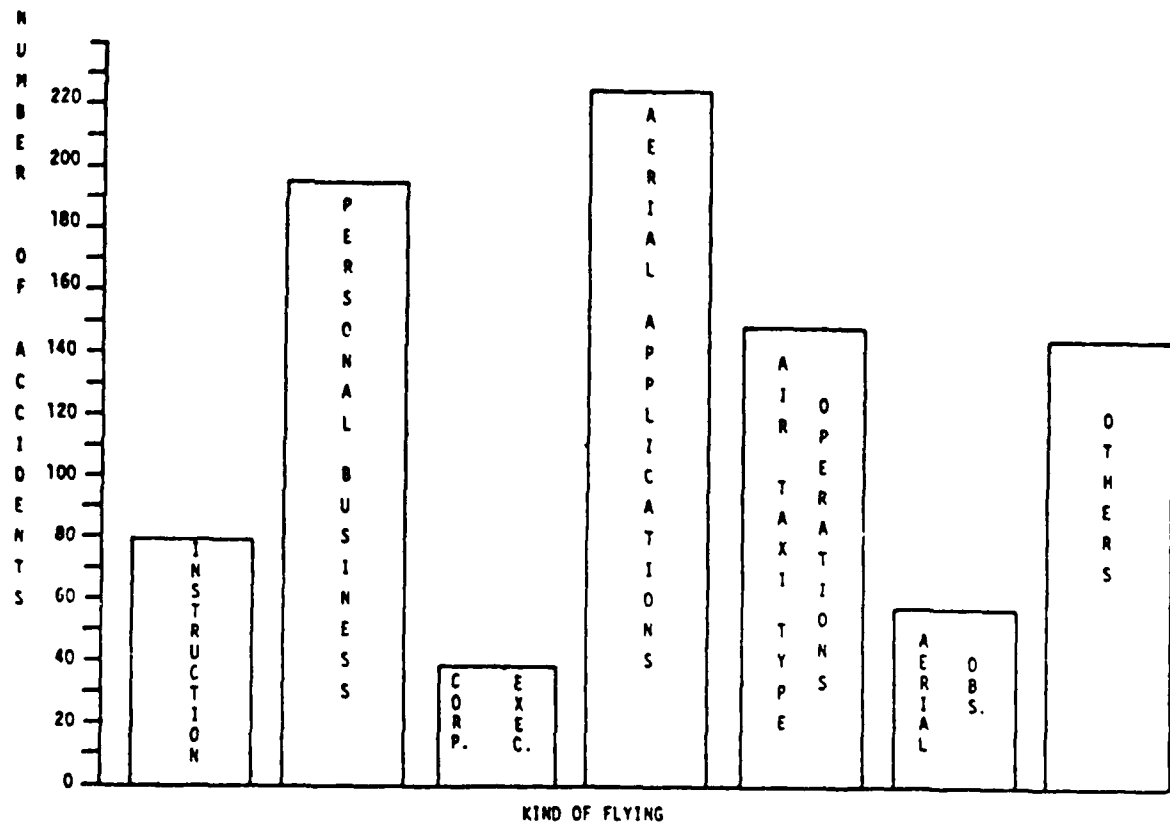
<u>Kind of Flying</u>	<u>Hours Flown</u>	<u>Percentage of Hours</u>	<u>Accidents</u>	<u>Accident Rate*</u>
Instructional	366,684	5.5	80	21.82
Personal/Business	623,001	9.4	196	31.46
Corporate/Executive	689,191	10.4	38	5.51
Aerial Application	734,389	11.0	225	30.64
Air-Taxi-Type Operations	2,558,639	38.5	148	5.78
Other	<u>1,679,238</u>	<u>25.2</u>	<u>203</u>	<u>12.09</u>
Total	6,651,142	100.0	890	13.38

\* Per 100,000 hours.

Source: NTSB, Special Study - Review of Rotorcraft Accidents, 1977-1979.

Figure 21

DISTRIBUTION OF ACCIDENTS IN RELATION TO KIND OF FLYING



Source: NTSB Special Study - Review of Rotorcraft Accidents, 1977-1979

#### 4.6.2 Offshore Accident Rates

The HSAC keeps accident statistics on rotorcraft operating in the Gulf of Mexico performing the offshore transport mission. The data is collected as part of a survey sent to its operator members and may not represent accidents for all helicopters operating in that region. Table 27 illustrates the data that has been collected by HSAC.

TABLE 27  
HSAC OFFSHORE ACCIDENT RATES

<u>YEAR</u>	<u>HOURS FLOWN</u>	<u>ACCIDENTS</u>	<u>ACCIDENT RATE PER 100,000 HRS</u>
1985	719,304	13	2.09
1986	691,655	17	2.45
1987	455,330	9	1.97
1988	515,707	8	1.55

Source: HSAC

The Gulf of Mexico statistical operation activity and accident rates are compiled annually from information submitted voluntarily by HSAC membership. The information submitted is not verified or reviewed for accuracy by the HSAC and should be treated as unofficial. The HSAC has no reason to believe that the data is substantially incorrect or unrepresentative. However, the HSAC assumes no liability for accuracy or completeness of the data.

#### 4.6.3 Emergency Medical Service Accident Rates

The aeromedical helicopter accident statistics presented in Table 28, were compiled by Hospital Aviation and presented in the February 1988 issue.

TABLE 28  
AEROMEDICAL ACCIDENT STATISTICS: 1972-1988

<u>YEAR</u>	<u>NUMBER OF HELICOPTER PATIENT TRANSPORTS</u>	<u>ACCIDENTS</u>	<u>ACCIDENT RATE PER 100,000 PATIENT TRANSPORTS</u>
1972-79	30,168	5	16.5
1980	17,483	3	17.1
1981	25,013	4	16.0
1982	32,027	8	25.0
1983	41,097	7	17.1
1984	51,855	6	11.6
1985	68,694	10	14.6
1986	87,299	13	14.9
1987	105,000	4	3.8
1988	<u>120,900</u>	<u>7</u>	<u>5.8</u>
TOTAL	579,536	67	11.6

Source: Hospital Aviation, February 1988.

Surveys returned to Hospital Aviation revealed that the number of patients and flight hours is nearly synonymous, with 1.05 revenue flight hours per patient. These accident statistics reflect accidents which

involve 1) a helicopter configured primarily for EMS, 2) a pilot hired primarily to fly EMS missions, and 3) a mishap classified as an accident by NTSB according to 14 CFR Part 830.

NTSB published a report, Safety Study - Commercial Emergency Medical Service Helicopter Operations, January 28, 1988, that documents the investigation and evaluation of 59 accidents involving EMS helicopter operations that occurred between May 11, 1978, and December 3, 1986. Forty-seven of these accidents occurred during EMS missions defined by NTSB as "flight conducted for patient transport, including the flight to the patient's location and return." Accident rate data are presented for comparison purposes in Table 29 for EMS, 14 CFR Part 135 and all turbine helicopters. The EMS rate was determined by using hours flown based on information provided by industry sources. 14 CFR Part 135 and turbine helicopter accident rates were determined using information on hours flown contained in FAA's General Aviation Activity and Avionics Survey annual summation reports. Figures 22 and 23 compare the commercial EMS helicopter accident rates to those for 14 CFR Part 135 nonscheduled air taxis and turbine-engine helicopters. These two graphs are taken from Appendix D of NTSB's Safety Study - Commercial Emergency Medical Service Helicopter Operations.

TABLE 29  
ACCIDENT STATISTICS  
COMMERCIAL EMS HELICOPTERS, TITLE 14 CFR PART 135 NONSCHEDULED  
AIR TAXI HELICOPTERS, AND ALL TURBINE-POWERED HELICOPTERS  
1980 THROUGH 1985

YEAR	TOTAL ACCIDENT			HOURS FLOWN			TOTAL ACCIDENT RATE		
	EMS	135	ALL TURB	EMS	135	ALL TURB	EMS	135	ALL TURB
1980	2	47	126	20,750	423,277	1,602,852	9.63	11.10	7.86
1981	3	47	124	28,071	320,369	1,754,422	10.68	14.67	7.06
1982	6	32	129	36,764	709,381	1,771,174	16.32	4.51	7.28
1983	5	25	124	45,233	546,713	1,699,652	11.05	4.57	7.29
1984	6	43	140	56,516	873,270	1,903,315	10.61	4.92	7.35
1985	10	27	116	71,831	429,760	1,590,315	13.92	6.28	7.29
Total	32	221	759	259,165	3,302,770	10,321,669	12.34*	6.69*	7.35*

\* 6-Year Mean

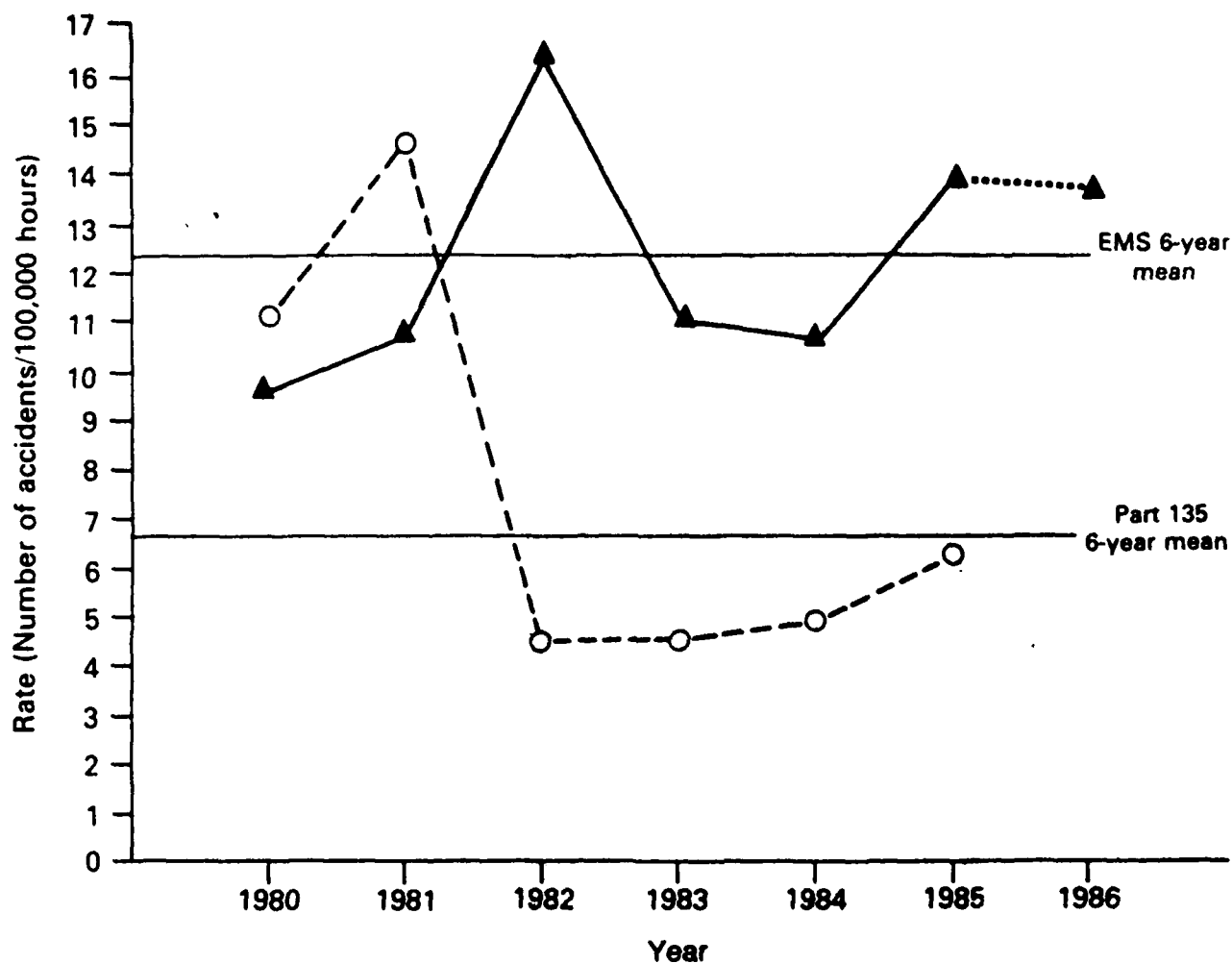
Source: NTSB Safety Study - Commercial Emergency Medical Service Helicopter Operations, January 28, 1988.

#### 4.6.4 Additional Accident Data

Rotorcraft accident data categorized by mission are available at a cost from Robert E. Breiling Associates in Boca Raton, Florida. Accident data are gathered from a variety of sources including insurance companies and the NTSB accident database. The accidents are then classified by mission being flown during occurrence, aircraft type, accident cause, etc. The classification of accidents by missions are made by the FAA according to primary use as discussed in Section 4.1.1.1. The commercial category is defined in terms of air taxi, offshore, and sling load. A database of twin turbine helicopters is complete and a database of single engine turbine helicopters is in progress. Piston helicopter accidents are not represented by the data collected. This is the only known source of accident data classified by mission that encompasses civil helicopter accidents since they were first recorded.

Figure 22

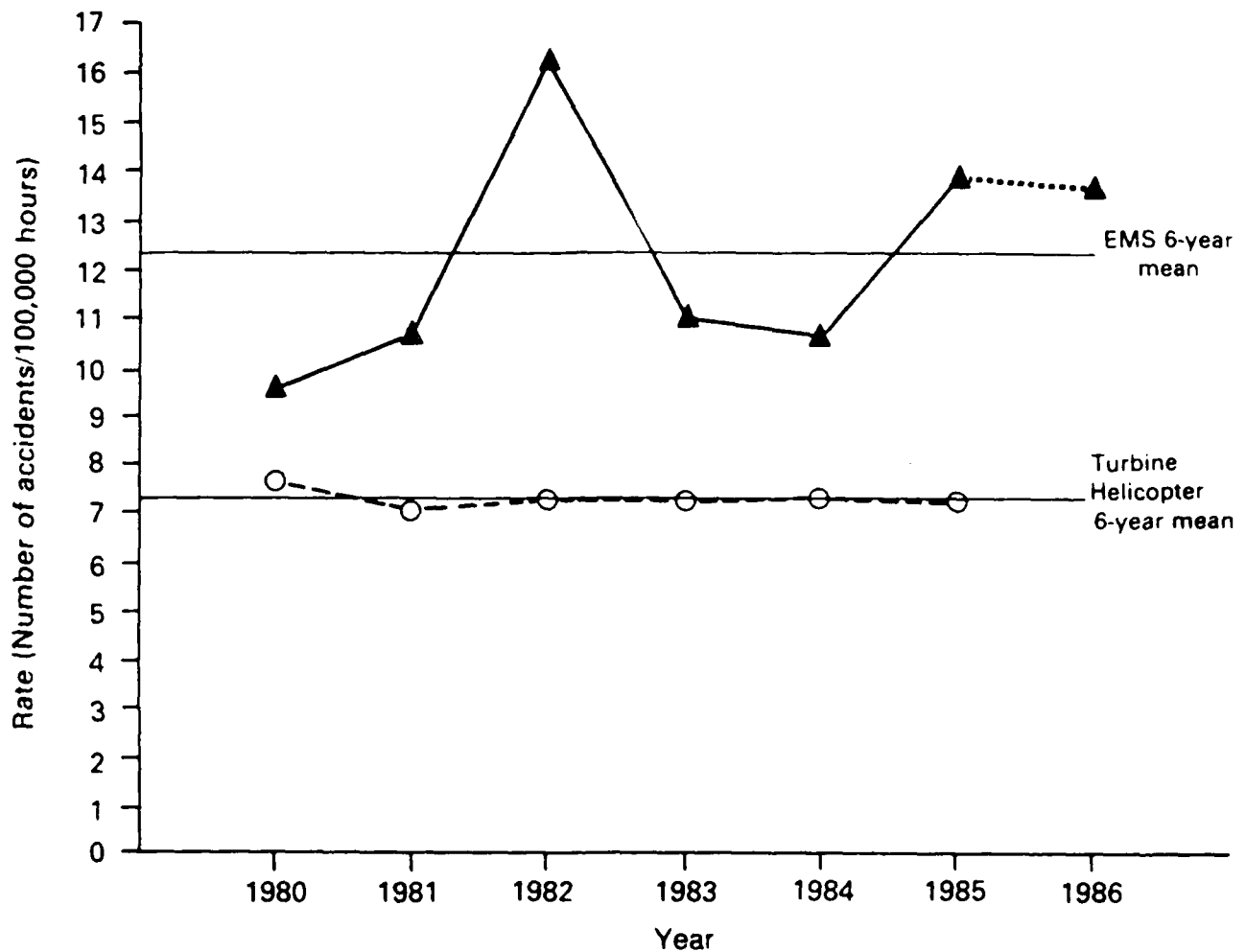
ACCIDENT RATE, COMMERCIAL EMS HELICOPTERS AND  
14 CFR PART 135 NONSCHEDULED HELICOPTER AIR TAXIS 1980-1985



- ▲ EMS Helicopters —————
- Part 135 nonscheduled helicopter air taxis - - - - -
- \* EMS helicopter data based on accidents which involved patient transportation
- ..... The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the part 135 data or in the calculation of the 6-year EMS accident rate mean.

Source: NTSB Safety Study - Commercial Emergency Medical Service  
Helicopter Operations, January 28, 1988.

Figure 23  
ACCIDENT RATE, COMMERCIAL EMS HELICOPTERS AND  
TURBINE ENGINE HELICOPTERS 1980-1985



- ▲ EMS Helicopters —————
- Turbine Engine Helicopters - - - - -
- \* EMS helicopter data based on accidents which involved patient transport
- ..... The 1986 data for EMS is provided for the readers information only. These data were not used in comparison to the Part 135 data or in the calculation of the 6-year EMS accident rate mean.

Source: NTSB Safety Study - Commercial Emergency Medical Service  
Helicopter Operations, January 28, 1988.

This section of the report addresses geographic factors that affect the density and frequency of helicopter operation. The entire conterminous United States (CONUS) is considered, as a first step, in determining mission operating areas and helicopter locations. Those missions that benefit most from improved or increased low altitude CNS were determined in Section 3.0. The operating areas of these missions are discussed below as well as the weather data that will be correlated with them. In some cases (EMS, Search and Rescue, Air Taxi/Commercial) the mission's operating area is diverse, with small numbers of operations widely distributed throughout the CONUS. In other instances (Corporate/Executive, Business, Offshore, Scheduled Commuter), mission operating areas are less diverse and exhibit high densities of operations per area. These missions with high density operations will be studied down to the county level.

### 5.1 NATIONAL HELICOPTER DISTRIBUTION

Figure 24 is a DOT distribution map of all the registered helicopters, by county, in the United States. Specific helicopter model data by geographic area follow in Tables 30 through 36. The helicopters most prevalent in the Gulf Coast area, predominately supporting offshore missions, are the Bell 206 variants and the AS 355 as shown in Table 30. The Bell 212, Sikorsky S-76 and MBB BO-105 are also found operating in large numbers in the Gulf Coast area. In the Philadelphia area where corporate/executive and business operations are prevalent, the Bell 206 is again the most predominant helicopter, in both number and operations as shown in Tables 31 and 32. The Boston area, as indicated in Tables 33 and 34, is homebase for a large number of Bell 206's as well as Robinson R22's and Sikorsky S-76's. The Bell 206 leads in the number of operations, followed by the S-76 and the Aerospatiale 350.

In the state of New Jersey, the Bell 206 is again the predominant model while the Sikorsky S-76 is second (Table 35). The Downstate New York area is also where a large number of Bell 206's are located as shown in Table 36. The Sikorsky S-76 and the combined numbers of Aerospatiale 350 and 355 follow second and third in numbers of helicopters.

### 5.2 SELECTED MISSION GEOGRAPHIC REGIONS

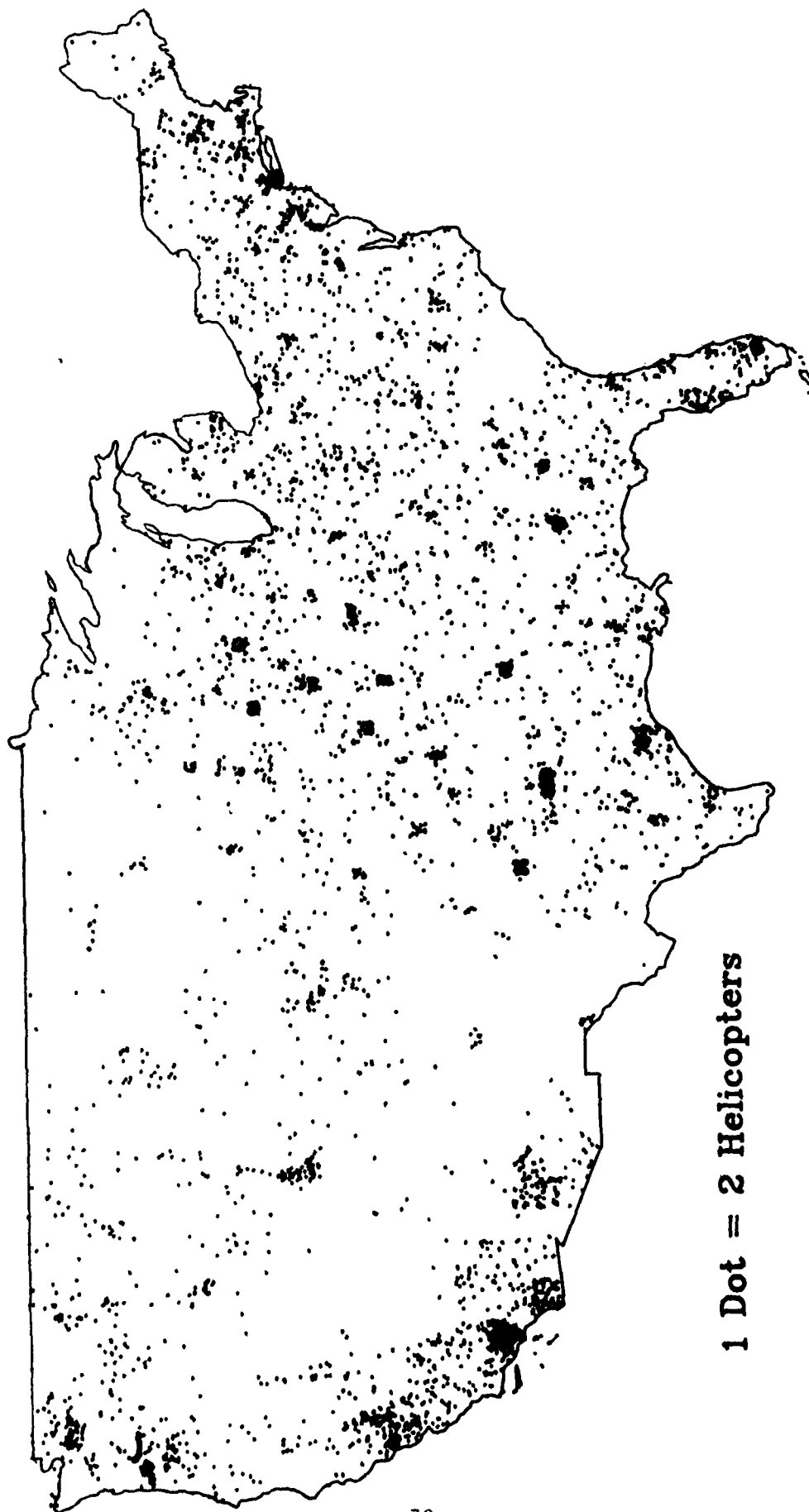
The geographic regions for each mission were selected from the actual distribution of each of the seven helicopter missions. The location of each mission was determined by data collected, discussions with individual operators, and industry experts.

#### 5.2.1 EMS

EMS operations are found in almost every part of the United States, in urban, suburban, and rural settings. Figures 25 through 30 show the location of hospital-based EMS operators by region. The maps show the service coverage area for each region by portraying a radius of the average trip length of its corresponding region as determined by Hospital Aviation (Table 16). In AC 135-14, Emergency Medical Service-Helicopters,

Figure 24

# HELICOPTER DISTRIBUTION IN THE UNITED STATES



1 Dot = 2 Helicopters

Source: FAA Census of Civil Aircraft, 1986.

TABLE 30  
GULF COAST HELICOPTER DATA

<u>Aircraft</u>	<u>Number</u>	<u>IFR Equipped</u>
Bell 206A/B	206	0
Bell 206L1	170	0
Bell 206L3	13	0
Bell 222A/B	4	2
Bell 222UT	9	8
Bell 212	46	25
Bell 412	34	34
Bell 214ST	2	2
BO-105	53	0
BK-117	5	0
AS-350	28	0
AS-355	72	0
SA-330, 332	9	9
SK-76	54	54
SK-62	<u>3</u>	<u>0</u>
TOTAL	708	134

Source: HSAC Survey as of 12/31/86.

TABLE 31  
PREDOMINANT HELICOPTER MODELS IN PHILADELPHIA AREA

<u>Model</u>	<u>Number</u>	<u>Percent</u>	<u>Engine</u>
Bell 206 Jet Ranger	64	24%	Turbine
Sikorsky S-76	37	14%	Turbine
MBB BK 117	32	12%	Turbine
MBB BO 105	26	10%	Turbine
Aerospatiale 350	20	8%	Turbine
Bell 206 Long Ranger	15	6%	Turbine
Bell 222	15	6%	Turbine
All Others	56	20%	Various
TOTAL	265	100%	

Source: Edwards & Kelcey, Philadelphia System Plan, 1988.

TABLE 32  
HELICOPTER OPERATIONS BY MODEL IN THE PHILADELPHIA AREA

Model		Total Estimated Annual Operations by Model Type	Total Helicopters	Average Operations/Model/ Helicopter
Aerospatiale 330		2,041	1	2,041
Aerospatiale 341		1,277	1	1,277
Aerospatiale 350		19,829	20	991
Aerospatiale 355		23,872	7	3,410
Aerospatiale 365		5,532	2	2,766
Agusta 109		16,681	7	2,383
Bell 47		11,914	7	1,702
Bell 206		151,817	79	1,922
Bell 212		1,277	1	1,277
Bell 222		42,643	16	2,665
Bell 412		3,404	4	851
Bell UH1		4,681	6	669
Enstrom 280		1,170	4	293
Hiller 110		638	1	638
Hiller 112		1,277	6	213
Hughes 500		8,936	3	2,979
Hughes 300		10,000	3	3,333
MBB BO 105		7,660	25	304
MBB BK 117		17,234	30	574
MDC 500		426	1	426
Robinson R-22		2,979	2	1,489
Sikorsky S58		21,277	2	10,638
Sikorsky S76		93,638	37	2,531
TOTAL		450,203	265	

Source: Edwards & Kelcey, Philadelphia System Plan, 1988.

TABLE 33  
PREDOMINANT HELICOPTER MODELS IN BOSTON AREA

Model	Number	Percent	Engine
Bell 206 Jet Ranger	47	39%	Turbine
Robinson R-22	17	14%	Piston
Sikorsky S-76	14	12%	Turbine
Aerospatiale 350	8	7%	Turbine
Bell UH-Military	8	7%	Turbine
Bell 47	7	6%	Turbine
All Others	20	15%	Various
TOTAL	121	100%	

Source: Edwards & Kelcey, Boston System Plan, 1988.

TABLE 34  
HELICOPTER OPERATIONS BY MODEL IN THE BOSTON AREA

Model	Total Estimated Annual Operations by Model Type	Total Helicopters	Average Operations/Model/ Helicopter
Aerospatiale 350	12,351	8	1,544
Aerospatiale 360	1,114	1	1,114
Agusta 109	3,071	4	768
Bell 47	686	7	98
Bell 47 Turbine	N/A	1	N/A
Bell 206	55,607	47	1,183
Bell UH1	N/A	1	N/A
Enstrom 280	129	6	21
Hiller Turbine	600	1	600
Hughes 500	N/A	2	N/A
MBB BO 105	4,120	3	1,373
MBB BK 117	2,550	1	2,550
Sikorsky S76	17,441	14	1,246
Robinson R-22	N/A	17	N/A
Other Turbine	720	1	720
TOTAL	98,359	121	

N/A = Not Available

Source: Edwards & Kelcev, Boston System Plan, 1988.

TABLE 35  
PREDOMINANT HELICOPTER MODELS IN NEW JERSEY

Model	Percent
Bell 206 Jet Ranger	27.6%
Sikorsky S-76	18.1%
Bell 47	13.3%
Hiller UH-E	11.4%
Bell 222	6.7%
TOTAL	77.1%*

\* This study only listed the top five helicopters.

Source: Edwards & Kelcey, New Jersey System Plan, 1985.

TABLE 36  
PREDOMINANT HELICOPTER MODELS IN THE DOWNSTATE NEW YORK AREA

Model	Number	Percent	Engine
Bell 206 (all variants)	77	34%	Turbine
Sikorsky S-76	43	19%	Turbine
Aerospatiale 350, 355	30	13%	Turbine
Bell 222	10	4%	Turbine
Robinson R-22	9	4%	Piston
All Others	56	26%	Various
TOTAL	225	100%	

Source: Edwards & Kelcey, Downstate New York System Plan, 1988.

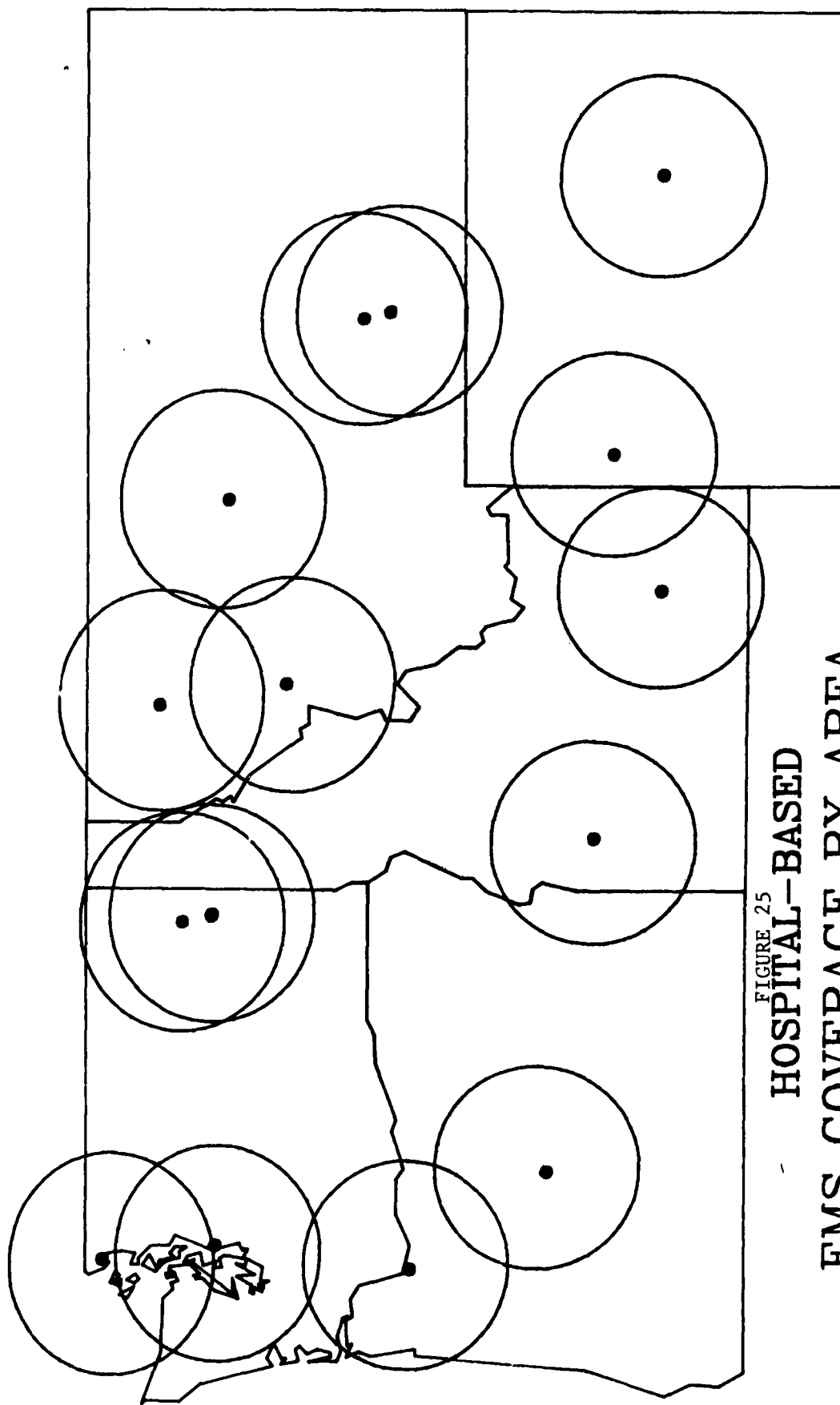


FIGURE 25  
HOSPITAL-BASED

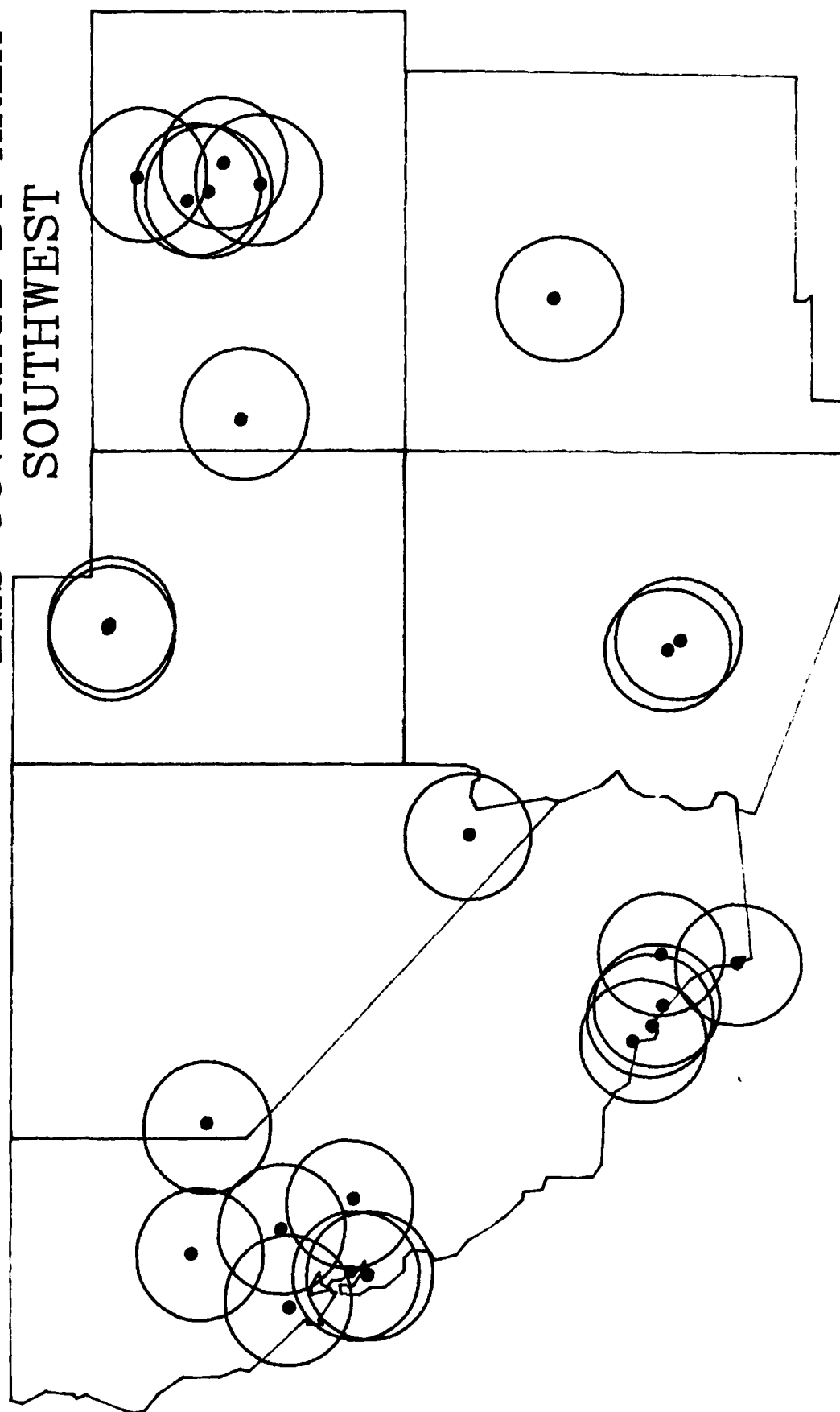
## EMS COVERAGE BY AREA NORTHWEST

○ = 75 Miles (Average trip distance in this area)

Source: "Hospital Aviation," March 1988.

FIGURE 26

# HOSPITAL-BASED EMS COVERAGE BY AREA SOUTHWEST



○ = 56 Miles (Average trip distance in this area)

Source: "Hospital Aviation," March 1968.

FIGURE 27

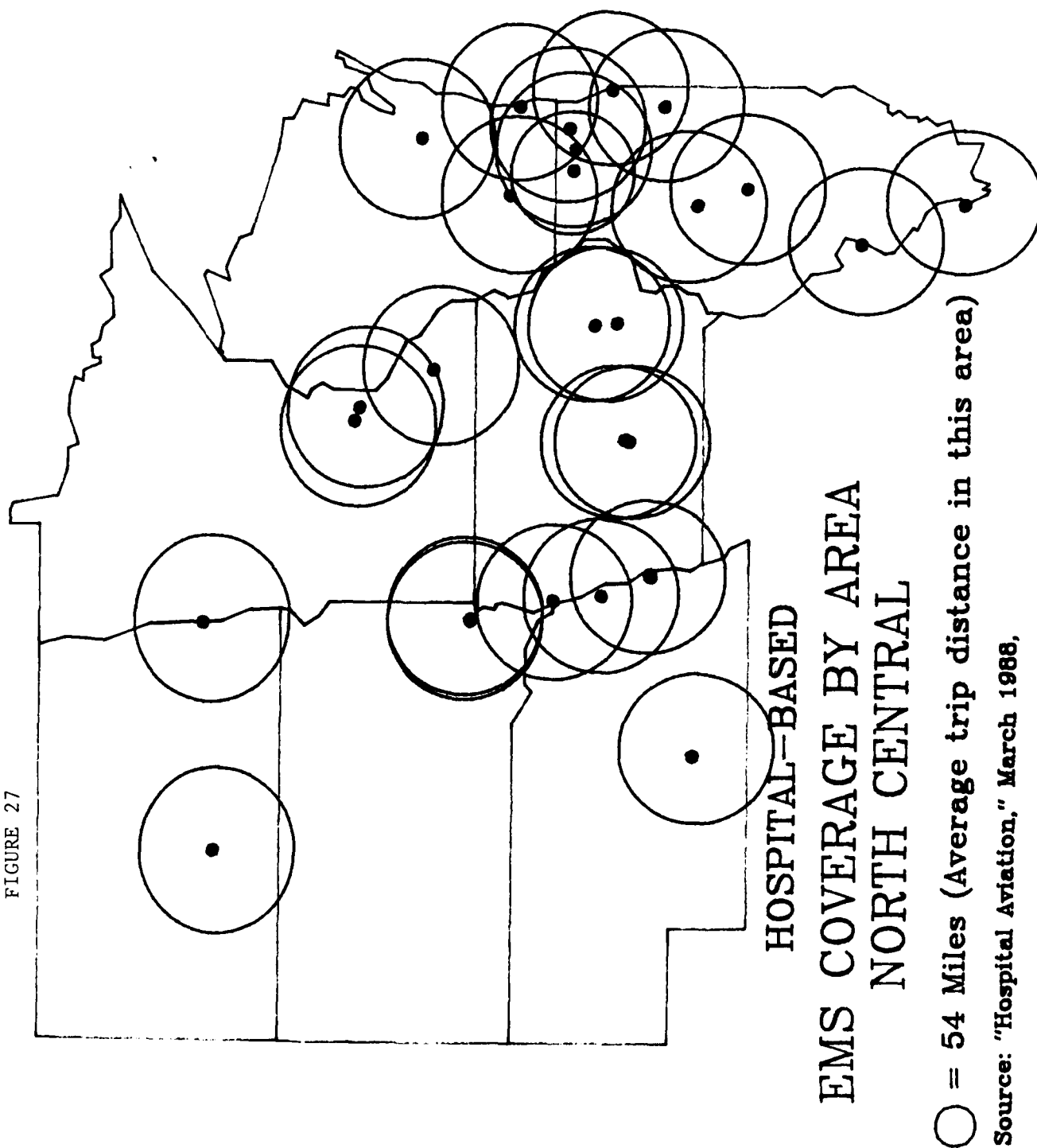
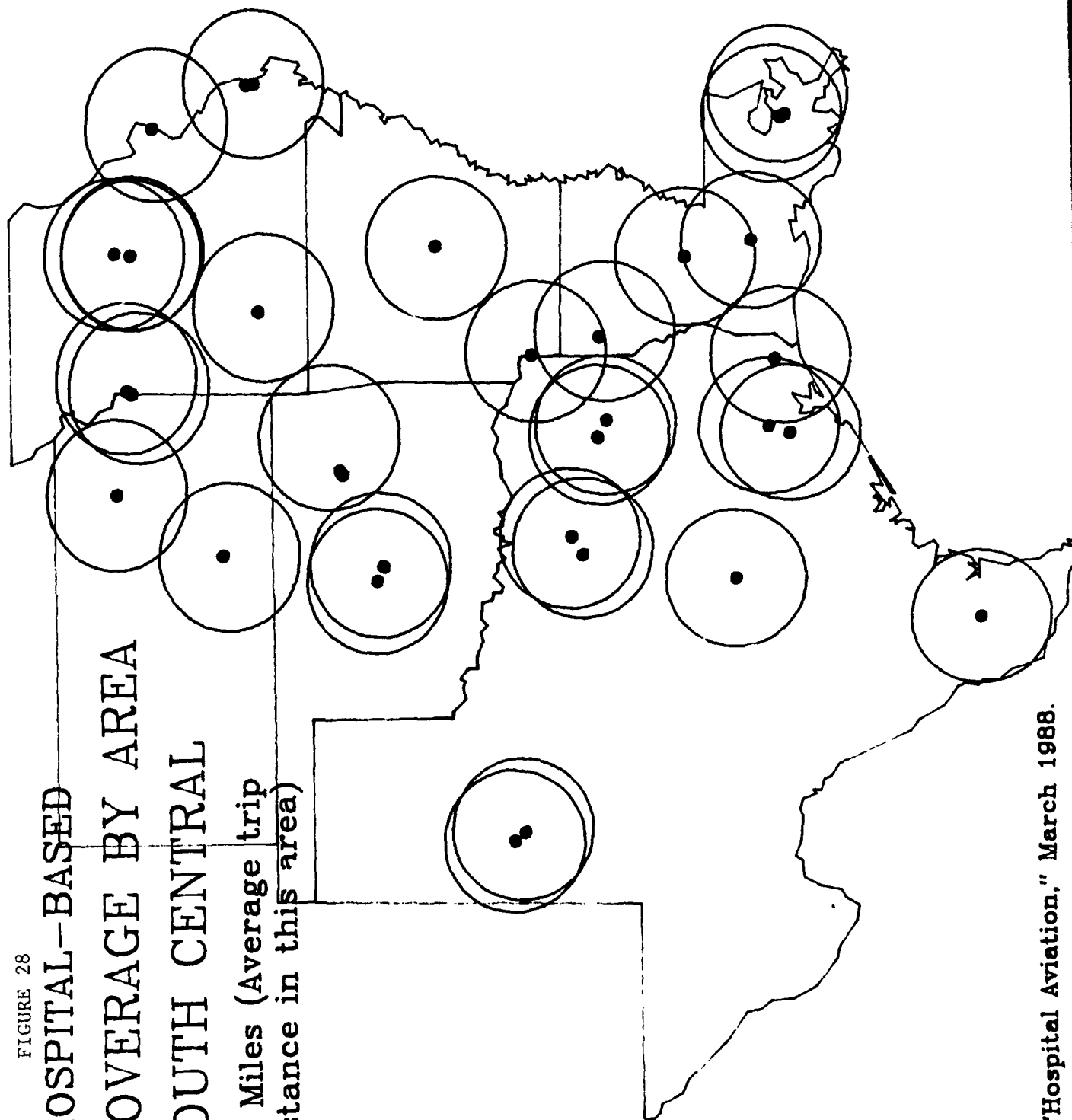


FIGURE 28

# HOSPITAL-BASED EMS COVERAGE BY AREA SOUTH CENTRAL

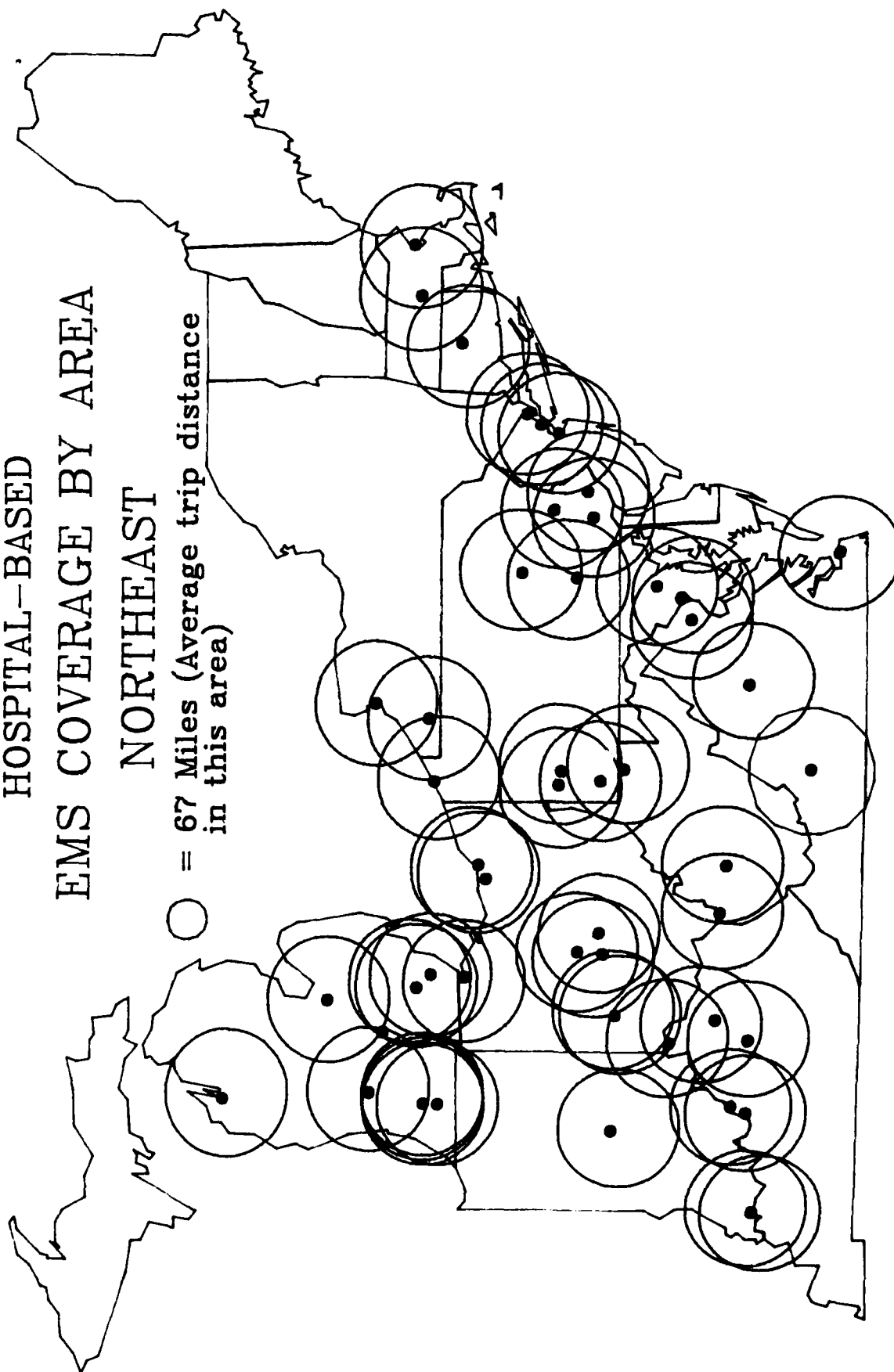
○ = 67 Miles (Average trip  
distance in this area)



Source: "Hospital Aviation," March 1988.

FIGURE 29

# HOSPITAL-BASED EMS COVERAGE BY AREA NORTHEAST



Source: "Hospital Aviation," March 1988.

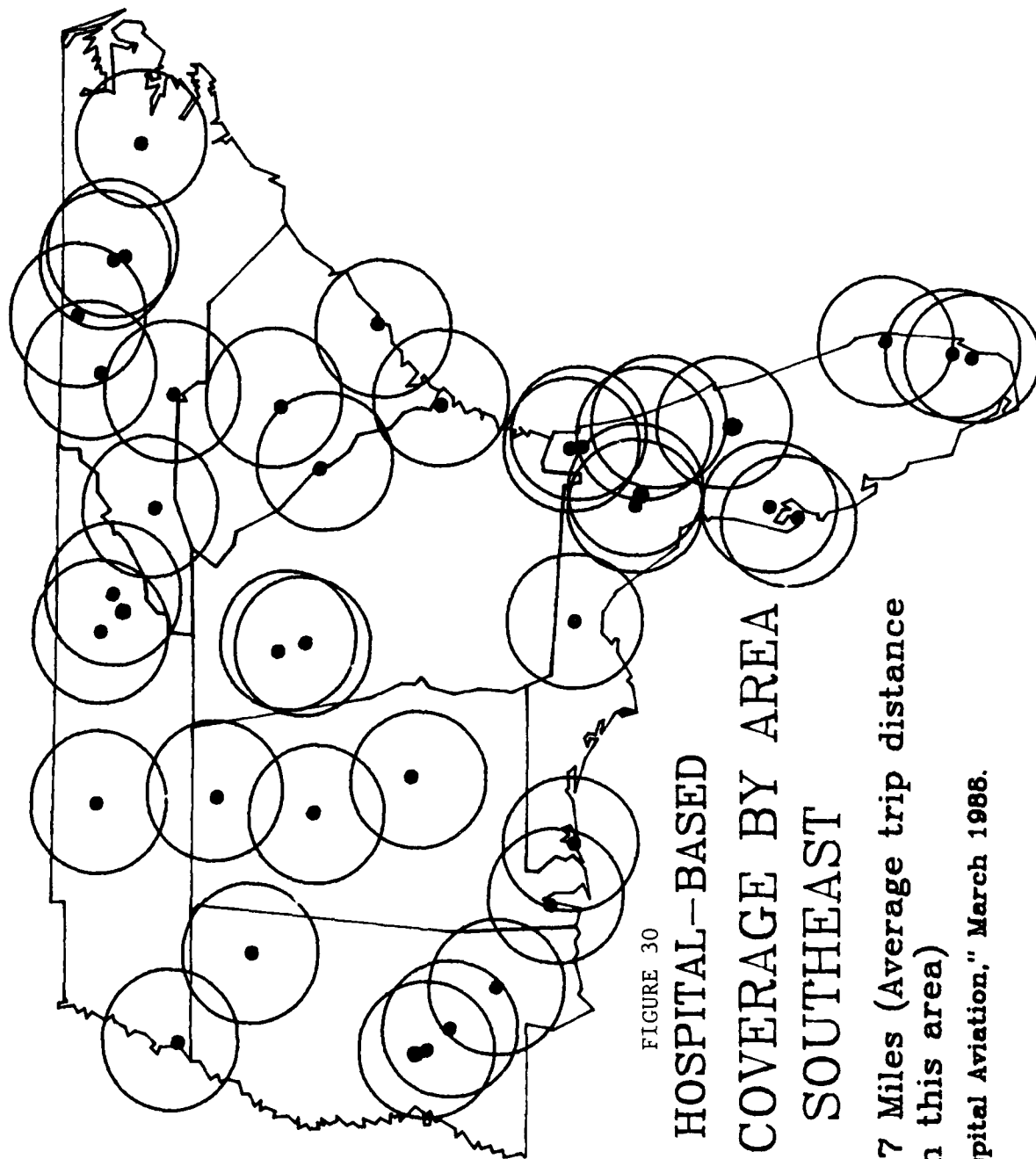


FIGURE 30

# HOSPITAL-BASED EMS COVERAGE BY AREA SOUTHEAST

○ = 67 Miles (Average trip distance  
in this area)

Source: "Hospital Aviation," March 1988.

the FAA has recommended that EMS operators define their "local" and "cross country" flying areas. Different minimums for day and night VFR flight are recommended as a function of whether a flight is local or cross country. Once this is accomplished we will be able to define the EMS operating areas more accurately.

Although there have been attempts to develop ways to predict where new EMS operations can be expected to occur, no reliable methodology has been developed at the present time. A rural area may require an EMS because of the inaccessibility of the area due to poor or few roads. Lack of specialized medical facilities such as burn, or trauma centers, may exacerbate the problem. Urban areas may have just as much a need for EMS service due to ground traffic congestion and more specialized medical centers. Furthermore, some hospitals may be in competition for patients within the same small area so both may acquire helicopters. Certain levels or densities of population may be a factor in prediction of future EMS locations, but correlation for any of these factors has yet to be proven.

#### 5.2.2 Corporate/Executive

The corporate/executive mission is found throughout the country. According to industry sources approximately 25 percent of all helicopter activity can be considered corporate/executive. However, this mission is more heavily concentrated in some areas than in others. The heaviest concentration is in the northeastern United States incorporating Boston, New York, and Washington, D.C. This is also where the largest, most fully equipped helicopters operate, and it is an area where there is a higher likelihood of encountering IMC. The northeast has some of the most heavily used airspace in the United States as well as an increasing airport congestion problem. Figure 31 shows the concentration of Part 91 operators in the United States. In the northeast the primary mission of 74 percent of all 14 CFR Part 91 operators is recorded as corporate/executive.

#### 5.2.3 Scheduled Commuter

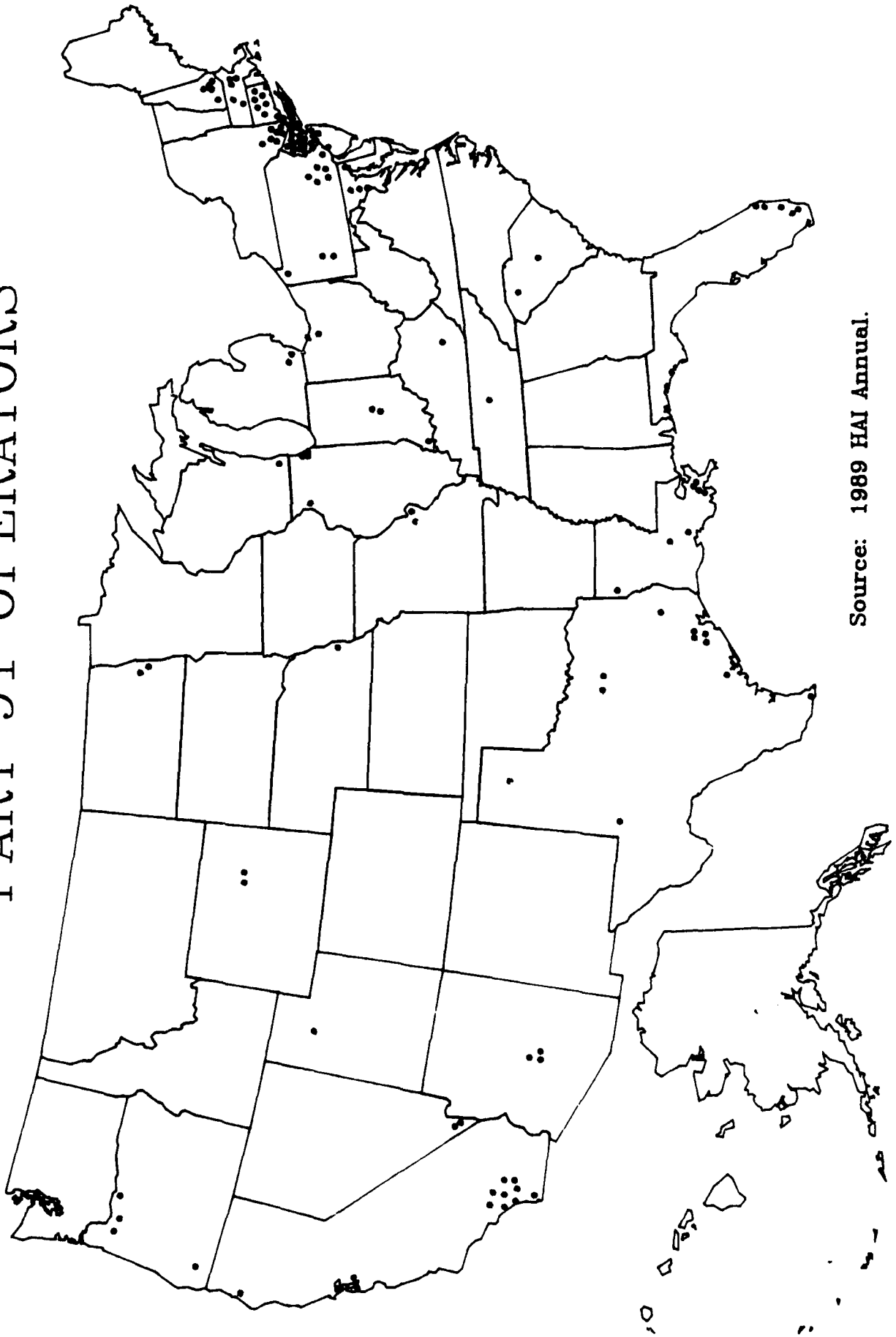
Scheduled commuters are invariably located in major metropolitan areas. Their operational areas are usually relatively small, incorporating areas with radii of only 25-50 miles. Five operators currently operate in the New York, New Jersey, Los Angeles, and Boston (2) metropolitan areas. The activity areas were defined from conversations with these operators. Figure 32 presents the locations of the five current and six previously scheduled commuter operations in the United States.

#### 5.2.4 Offshore

The heaviest concentration of offshore helicopter support is in the southeastern United States along the Gulf of Mexico from Texas to Alabama. Although there are some offshore operations in Alaska and in southern California, the Gulf of Mexico location will be the only one evaluated in this study since over 90 percent of all the offshore production comes from the Gulf. This productivity accounts for the high level of helicopter activity and support services for helicopters in the Gulf of Mexico region. Figures 33 and 34 are maps of current offshore lease areas and active platforms within them. There are approximately

Figure 31

# PART 91 OPERATORS



Source: 1989 HAI Annual.

Figure 32

# SCHEDULED HELICOPTER COMMUTER LOCATIONS

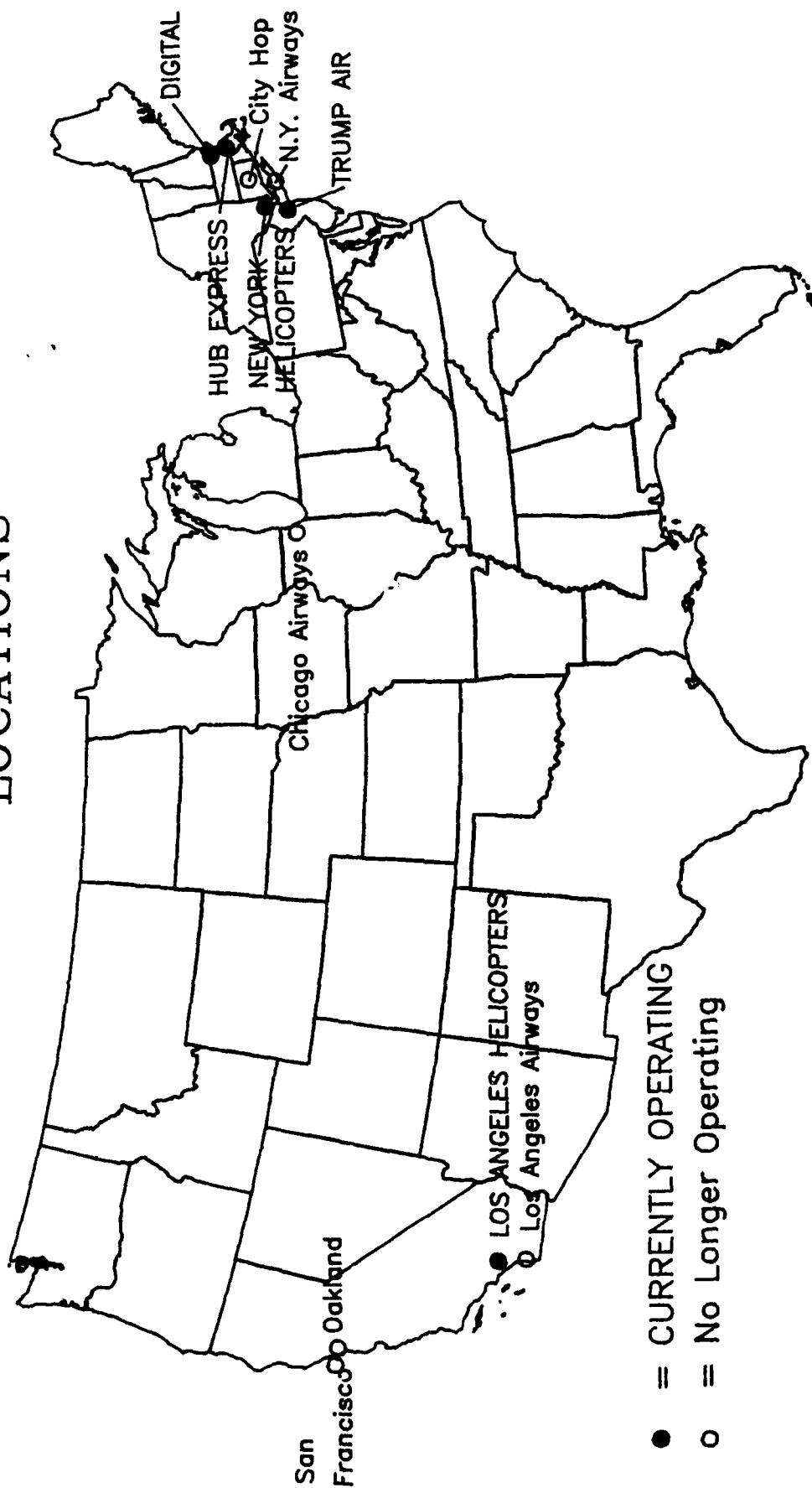
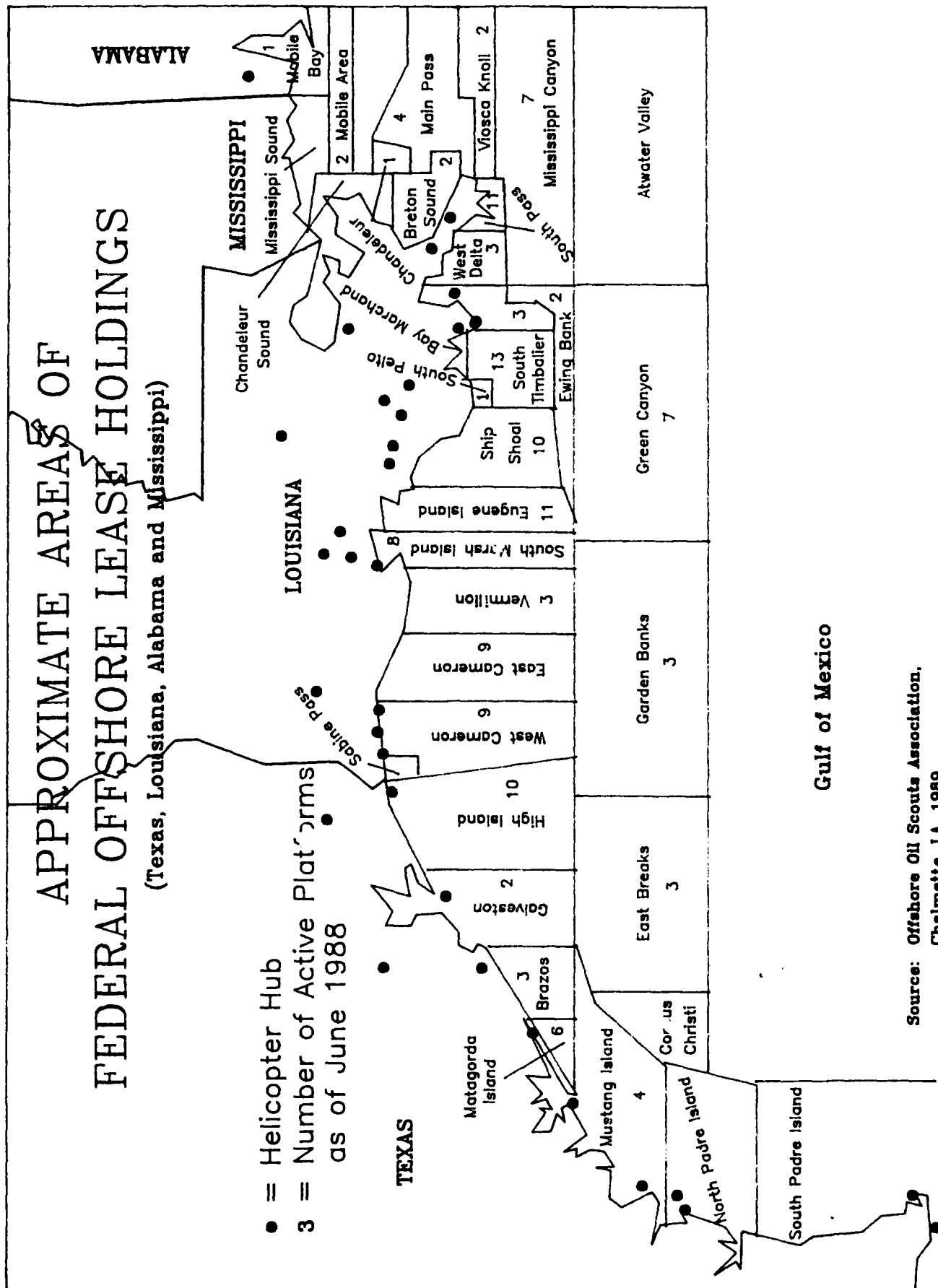


Figure 33



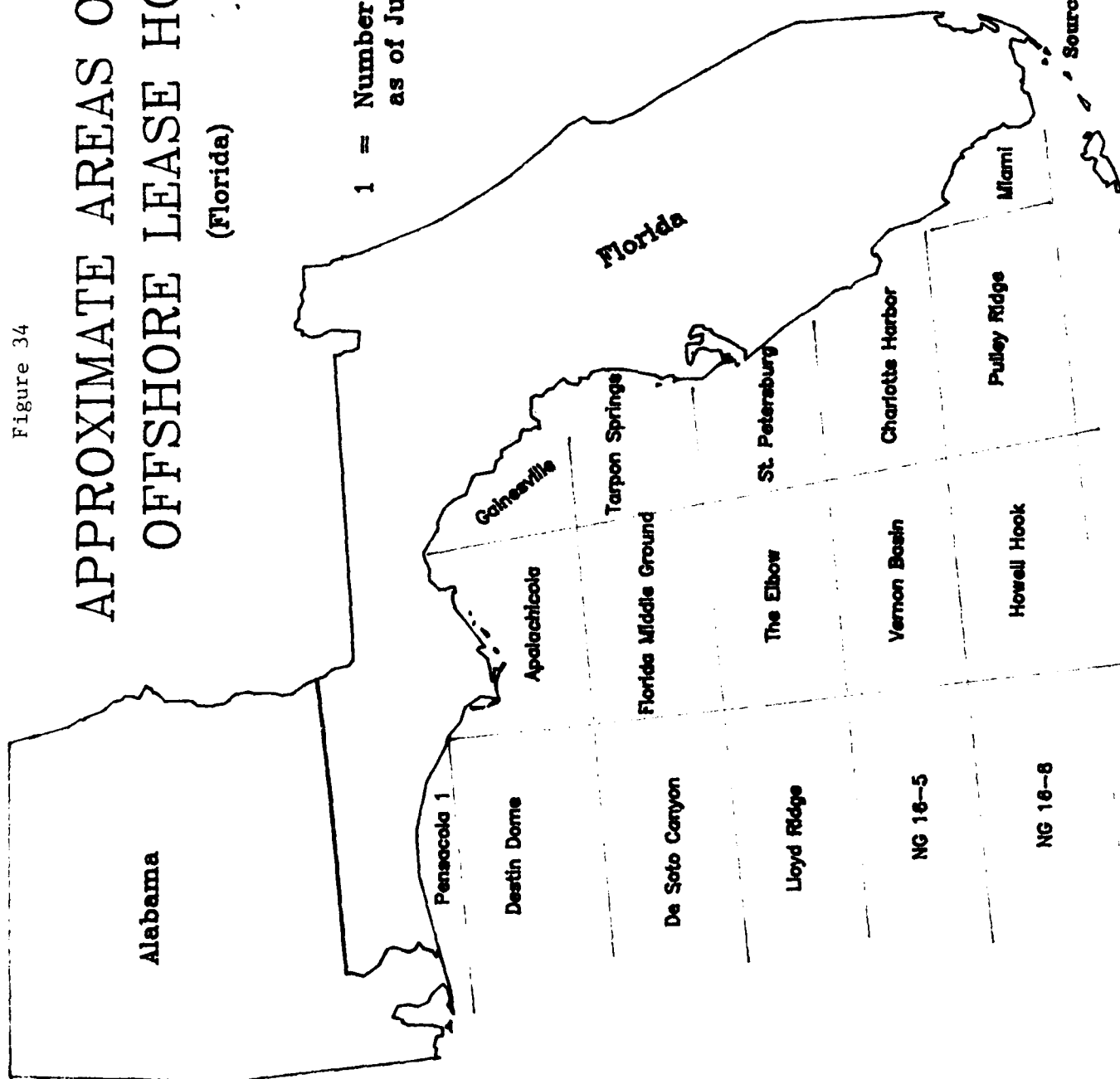
Source: Offshore Oil Scouts Association,  
Chalmette, LA, 1989

Figure 34

# APPROXIMATE AREAS OF FEDERAL OFFSHORE LEASE HOLDINGS

(Florida)

1 = Number of Active Platforms  
as of June 1988



Source: Offshore Oil Scouts Association  
Chalmette, LA, 1989

1,500 offshore helipads and over 33,000 wells in the Gulf of Mexico, but the number of active wells with both platforms and helipads dictates the helicopter activity at any one time. The number of active wells with platforms total 141 as of June 1988. This total represents about 75 percent of the peak Gulf of Mexico well activity encountered prior to the decline in oil and gas prices. The Minerals Management Service can supply separate databases of offshore platforms with helipads and offshore platform production statistics. With this information the number of helipads on platforms in production can be determined. The present offshore operational area extends as far out as 160 miles. By the end of the century, the leases located 200 miles out must be exploited or the companies will lose them. This is expected to increase the offshore operation area beyond 160 miles.

#### 5.2.5 Air Taxi/Commercial

Figure 14 indicates that air taxi/commercial operations occur throughout the United States. There are concentrations of these operators in the northeast and northwest United States, Southern California, and Florida. Some corporate/executive helicopters owned by corporations are used by nearby 14 CFR Part 135 operators when not required for executive use.

#### 5.2.6 Search and Rescue

Search and rescue missions are performed over land and water, in both urban and remote areas. Geographic regions where search and rescue missions occur most frequently include mountainous and coastal areas.

#### 5.2.7 Business

The business mission, like the corporate executive mission, is found throughout the country. Business use is probably more widely distributed than corporate/executive since smaller firms located outside the northeastern United States operate their own helicopters under 14 CFR Part 91. Other businesses may charter helicopters from Air Taxi/Commercial 14 CFR Part 135 operators as required to fulfill their business needs. Therefore an indication of business operating areas may be obtained by combining the information from Figure 14 with that from Figure 31. Examination of these figures shows that business missions would, like air taxi and commercial, occur most often in the northeastern United States, the northwestern United States, Southern California, and Florida.

### 5.3 WEATHER IMC PROBABILITIES

A national database of weather conditions at heliports does not exist, therefore existing airport data and coastal marine data were used to calculate weather probabilities at existing and potential areas of helicopter operations.

### 5.3.1 CONUS Weather Probabilities

Information on statistical weather probability for CONUS helicopter operating areas was obtained from the FAA Airport Specific File (ASF). The ASF is one of three FAA databases necessary to calculate equipment qualification ratios according to Airway Planning Standard No. 1 (APS.1) criteria. Weather data in the ASF was the result of averaging daytime weather observations taken over several years at 284 base airport locations. The weather probabilities for other airports were then interpolated from nearby base airports taking topological similarities into account. This technique was used to obtain weather statistics for an additional 1,355 airports for a total of 1637 airports in the ASF.

At each airport location in the ASF the probabilities that ceiling and visibility conditions will be within certain ranges per year are tabulated. The ranges used and the associated range names are shown in Table 37 below.

TABLE 37  
ASF WEATHER PROBABILITIES

Range Name	Ceiling (ft)	Visibility (sm)
WPA	0 - 200	0 - 1/2
WPB	200 - 300	1/2 - 3/4
WPC	300 - 400	3/4 - 1
WPD	400 - 600	1 - 1 1/2
WPE	600 - 800	1 1/2 - 2
WPF	800 - 1000	2 - 2 1/2
WPG	1000 - 1200	2 1/2 - 3
WPH	1200 - 1500	= 3

Source: Airport Specific File

### 5.3.2 Offshore Weather Probabilities

The National Weather Service (NWS) collects weather data from a number of supplemental aviation weather reporting stations (SAWRS) located at heliports and on platforms in the Gulf of Mexico. Table 38 is a list of current Gulf of Mexico SAWRS locations. These stations change frequently with relocation of platforms by offshore operators. Although weather from these locations are reported, they are not archived for statistical purposes by the NWS. Therefore, the observations per day for each reporting station for the period of years to be considered would have to be purchased from NWS, reviewed, manually input into a computer to create a database and averaged. To avoid this labor-intensive, time-consuming process, the Gulf of Mexico ceiling and visibility data collected by the U.S. Navy were related to each offshore lease area shown in Figures 33 and 34. In lease areas where visibility and ceiling values varied widely, the lease areas were divided into smaller sections to which constant ceiling and visibility values were assigned.

TABLE 38  
GULF OF MEXICO SAWRS LOCATIONS

	Number	Location
<b>Offshore</b>		
	41I	Eugene Island 266C (ERA)
	81A	Green Canyon 18 (ALG)
	5R0	High Island A323 (PHI)
	L40	High Island A474A (ALG)
	01T	High Island A511 (PHI)
	H39	High Island A572C (ALG)
	1G7	Mississippi Canyon 194 (PHI)
	30S	Ship Shoal 113/114SOB (ALG)
	S65	Ship Shoal 198G (ERA)
	S02	Ship Shoal 224A (ALG)
	T46	South Brazos A70 (PHI)
	7R8	South Marsh 130B (PHI)
	S58	South Timbalier 300 (PHI)
	9R9	Vermillion 245E (PHI)
	P95	West Cameron 480 (ALG)
	37C	West Cameron 556 (ERA)
<b>Onshore</b>		
	7R3	Amelia, LA (PHI)
	LBX	Brazoria County Airport (PHI)
	7R5	Cameron, LA (PHI)
	CWF	Chennault Field, LA (BAR)
	9F2	Fourchon, LA (PHI)
	6T5	Freeport, TX (ALG)
	L29	Grand Chenier, LA (ALG)
	AXO	Grand Isle, LA (PHI)
	7R4	Intracoastal City, LA (PHI)
	ARA	New Iberia, LA (BAR)
	ARA	New Iberia, LA (GAT)
	PTN	Patterson, LA (ALG)
	RKP	Rockport, TX (PHI)
	RPE	Sabine Pass, TX (PHI)
	7R1	Venice, LA (PHI)

ERA = ERA Helicopters

BAR = Bartons ATC

PHI = Petroleum Helicopters, Inc.

ALG = Air Logistics, Inc.

GAT = Gulf Air Transport

Source: National Weather Service, SAWRS Observational Spec., Lake Charles, LA.

### 5.3.3 Helicopter Weather Minimums

EMS helicopter operating minimums for both VFR and IFR conditions were obtained from the EMS Helicopter Advisory Circular AC - 135/14, appropriate sections of the Code of Federal Regulations-14, and Standard Instrument Approach Procedures. The conditions of interest are shown in Tables 39 and 40. Note that helicopters are authorized to reduce the required visibility for instrument approach procedures to runways by 1/2 but not less than 1/4 mi.

TABLE 39  
VFR HELICOPTER MINIMUMS

Mission/Airspace	Ceiling	Visibility
EMS (IAW AC 135-14)		
VFR Day-Local	500 ft	1 mi
VFR Day-Local (mountainous)	500 ft	2 mi
VFR Day-X-C	800 ft	2 mi
VFR Day-X-C (mountainous)	800 ft	3 mi
VFR Night-Local	800 ft	2 mi
VFR Night-Local (mountainous)	800 ft	3 mi
VFR Night-X-C (All)	1000 ft	3 mi
Other Missions (14CFR Part 91.105) - No Day/Night Differentiation		
In Control Zones	1000 ft	3 mi
Controlled Airspace Other than CZ (assuming minimum safe altitude of 300' and the requirement to remain 500' below clouds)	800 ft	1 mi
Outside Controlled Airspace (below 1200 ft. AGL)	Clear of Clouds	at a speed so as to be able to see and avoid other aircraft and/or obstruc- tions
Value assumed which would allow operation without hazard to persons or property on the ground	(500')	(1/2 mi)
Other Missions (14 CFR Part 91.107) - No Day/Night Differentiation		
In Control Zones	Clear of Clouds	None Specified
Value assumed which would allow operation without hazard to persons or property on the ground and to provide the ability to avoid other aircraft	(500')	(1/4 mi)

TABLE 40  
COMPARISON OF FIXED-WING AND HELICOPTER IFR MINIMUMS

Approach Procedure	Ceiling	Visibility
Nonprecision - fixed-wing (typical) CAT A	600-800 ft	1 mi
Nonprecision - helicopter (typical) (reduced segment lengths, higher descent gradients, 20:1 missed approach)	400-600 ft	1/2 mi
Precision - fixed-wing	200 ft	3/4 mi (1/2 w/lights)
Precision - helicopter (typical)	100 ft	1/2 mi (1/4 w/lights)

Source: Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS).

#### 5.3.4 Correlation of Weather Data to Helicopter Minimums

The tables in Section 5.2.2 indicate that depending on the type of mission, equipage of the helicopter and training of the pilot, critical ceiling, and visibility values range from 1,000 ft/3 mi to 200 ft/ 1/4 mile. Unfortunately, the probability ranges in the ASF do not correspond exactly to those values or the increments of interest. For the purposes of this analysis an assumption was made that the ceiling and visibility probabilities are independent. Therefore, they can be treated in separate calculations.

The probabilities of a given ceiling or visibility condition can be obtained by adding the ASF probabilities of all lower ceilings or visibilities. Tables 41 and 42 indicate the ASF probability ranges to be summed for each ceiling or visibility value.

TABLE 41  
HELICOPTER CEILING PROBABILITIES

Ceiling	ASF Probability Ranges
1000 ft	WPA + WPB + WPC + WPD + WPE + WPF
800 ft	WPA + WPB + WPC + WPD + WPE
500 ft	WPA + WPB + WPC + (WPD/2)
300 ft	WPA + WPB
200 ft	WPA

Source: Airport Specific File

TABLE 42  
HELICOPTER VISIBILITY PROBABILITIES

Visibility	ASF Probabilities Ranges
3 mi	WPA + WPB + WPC + WPD + WPE + WPF + WPG
2 mi	WPA + WPB + WPC + WPD + WPE
1 mi	WPA + WPB + WPC
1/2 mi	WPA
1/4 mi	WPA/2

Source: Airport Specific File

Data from the Summary of Synoptic Meteorological Observations (SSMO) and the U.S. Navy Climatic Study of the Caribbean Sea and Gulf of Mexico (USNCS) were used to calculate ceiling and visibility probabilities for offshore lease areas. The Summary of Synoptic Meteorological Observations was prepared under the direction of the U.S. Naval Weather Service Command by the National Climatic Center and contains data based upon observations made by ships passing through the Apalachicola, Pensacola, New Orleans, Galveston, and Corpus Christi offshore areas. The tables of percent frequency of visibility and percent frequency of ceiling heights by reporting hour and month were used. The historic period this data represents is 1865 through 1970. Hourly and monthly values were averaged to calculate a single value per area or section.

Table 43 illustrates the ceiling and visibility ranges reported in the study.

TABLE 43  
OFFSHORE WEATHER PROBABILITY RANGES

Ceiling ft.	Visibility	
	nm	sm
0-149	0 - 1/2	0 - .576
150-299	1/2 - 1	.576 - 1.152
300-599	1 - 2	1.152 - 2.304
600-999	2 - 5	2.304 - 5.76

nm = Nautical Miles

sm = Statute Miles

Because these ranges do not match those required for this study (Table 44), the averaged values were graphically interpolated to obtain data from the ranges required.

TABLE 44  
REQUIRED PROBABILITY RANGES

<u>Ceiling (ft)</u>	<u>Visibility (sm)</u>
1000	3
800	2
500	1
300	1/2
200	1/4

The U.S. Navy Climatic Study of the Caribbean Sea and Gulf of Mexico, Volumes 3 and 4, present isopleth maps and graphical interpretations of visibility and ceiling values by month. These data are from the same database of ship observations on which the SSMO was based, but are presented in a different manner. The best representations of values per lease area between the two studies were used and interpolated to the required ranges.

### 5.3.5 Correlation of Weather Data to Helicopter Operating Areas

Since the ASF was developed to assist in airport planning activities, it is keyed to airport locations. The location identifier (LOCID) of the airport is part of each record. These LOCID's were matched with airport LOCID's from the National Flight Data Center Airport File (NFDC-APT) of August 1988. The state, latitude, and longitude of the corresponding NFDC-APT records were then merged into the ASF weather database. This resulted in a database of weather probabilities for 1,637 airports and each airport's corresponding latitude, longitude and state. Ceiling and visibility probabilities from the airport nearest each heliport location in this database will be used to calculate benefits due to increased instrument approach capability including the additional flights that can be flown because of this increased capability.

Gulf of Mexico offshore missions operate between base heliports on land and heliports on platforms in the Gulf, as well as between platforms. Ceiling and visibility data for onshore heliport locations were taken from the database of merged ASF and NFDC-APT records. Values of ceiling and visibility for offshore lease areas were computed from the U.S. Navy studies and will be applied, per area, to the estimated number of active production platforms with heliports.

The purpose of this study is an analysis of costs and benefits rather than a detailed, rigorous estimation of the number of rotorcraft and hours flown. Therefore, previously published forecasts or surveys of rotorcraft activity are the basis for all estimates. These data sources are reviewed and the relative strengths and weaknesses are considered in terms of their applicability to the CNS benefit/cost analysis. Because of the uncertainty in the knowledge of the characteristics of both current and future helicopter operations, a range of likely values for each forecast parameter is identified rather than a single estimate.

#### 6.1 ROTORCRAFT OPERATIONS - HISTORICAL AND FORECAST DATA

The main body of knowledge regarding the history of rotorcraft operations is contained in the FAA General Aviation Activity and Avionics Survey. The results of this study are published annually by the FAA and, when combined with information from the Census of U.S. Civil Aviation, (1970-1976), provides an historical database on rotorcraft operations dating back to 1970. Data from these documents were contained in Helicopter Forecasting Assessment, a report prepared by Applied Systems Institute for the FAA Office of Aviation Policy and Plans, Systems and Policy Analysis Division (APO-100). This report will be referred to as the "ASI report" for the remainder of this study. The ASI report used FAA econometric methods to forecast rotorcraft fleet size, flight hours, and number of operations for each of the eight FAA primary use categories for the period 1988-2000.

##### 6.1.1 FAA Historical Data

The FAA historical fleet size data are shown in Figure 35. Starting in the late 1970's it is evident that the data shows significant year to year variation. This variation is believed to be a result of the sampling process caused by the small size of the helicopter fleet in relation to the overall size of the general aviation fleet. This is particularly true when the component categories of the helicopter fleet are considered. Variations of 50 percent or more are evident in some categories. Similar variations are evident in the FAA historical flight hour estimates for helicopters as shown in Figure 36. In both figures the total helicopter fleet size and flight hour curves show less variation, in terms of percentage, than do the component operational categories. This is likely due to the larger size of the sample represented by the total helicopter fleet. Typically about 25 percent of the helicopters represented in the aircraft registration files are surveyed each year. The relatively small helicopter population and poor response rate as compared to the fixed wing response (43 percent for helicopters vs. 53 percent for fixed-wing in 1986) produces these large sample variations. However, this data does represent a long history of operational data collected in a scientifically controlled survey. Therefore, even with its large variations it must be seriously considered in establishing a base from which to develop a forecast of expected future helicopter operations. The results of this survey were used as a basis for estimating operational forecasts for the corporate/executive, business, air taxi, and search and rescue missions.

Figure 35

# FLEET SIZE FORECAST

FAA HISTORICAL DATA

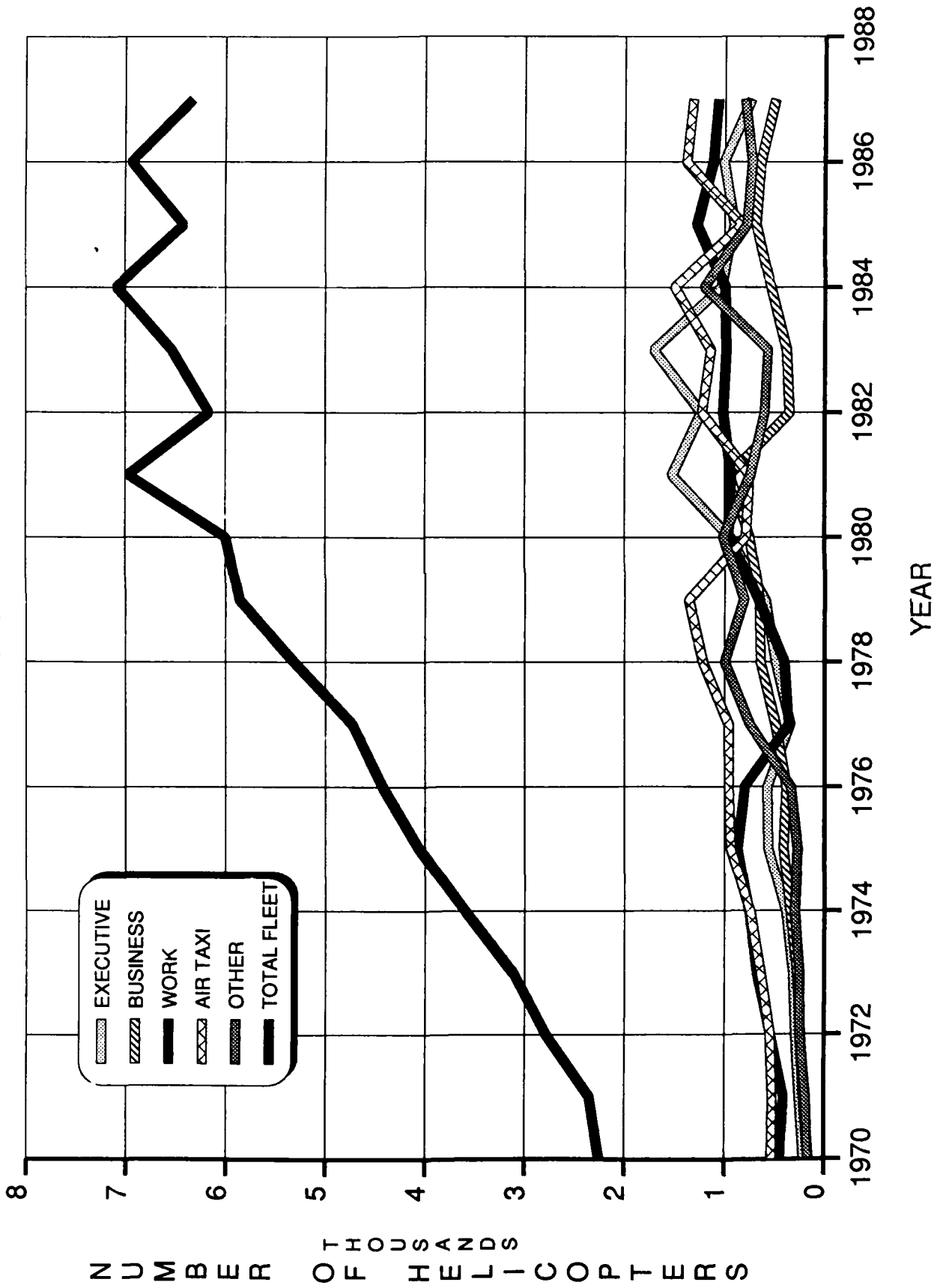
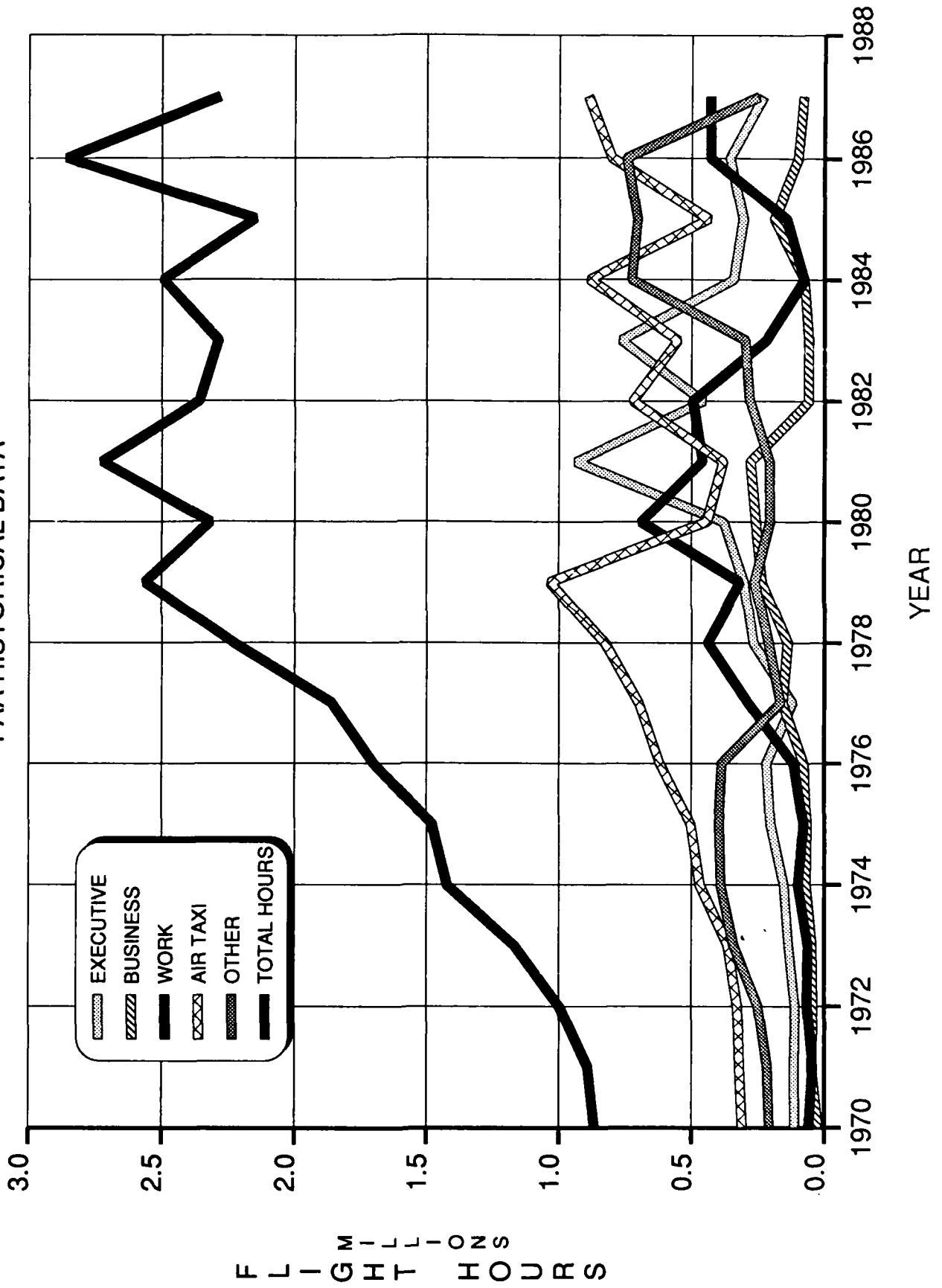


Figure 36

# FLIGHT HOUR FORECAST

FAA HISTORICAL DATA



### 6.1.2 Helicopter Foundation International Survey

The results of the 1987 survey of helicopter operators performed by the Helicopter Foundation International, described in Section 4.1.2, was analyzed in some detail in the ASI report. The results of this analysis produced conclusions that showed significant differences between the FAA survey and the HFI survey. These differences are shown in quantitative terms of fleet size estimates, Table 45, and flight hour estimates, Table 46, taken directly from the ASI report.

TABLE 45  
COMPARISON OF THE ESTIMATED ACTIVE HELICOPTERS  
FLEETS BY USE CATEGORY FOR THE HFI AND GA SURVEYS

PRIMARY USE	1987 HFI SURVEY		1987 GA SURVEY		GA SURVEY MEAN 1983-1987
	Number	%	Number	%	Number
EXECUTIVE	305	4	740	12	1079
BUSINESS	1,546	19	498	8	550
PERSONAL	534	7	835	13	717
INSTRUCTION	352	5	314	5	457
AERIAL APP.	917	13	756	12	728
WORK*	2328	33	1068	17	1087
AIR TAXI	1135	16	1319	21	1232
OTHER**	<u>207</u>	<u>3</u>	<u>811</u>	<u>13</u>	<u>816</u>
TOTAL	7124	100	6341	100	6666

\* The WORK category combines the AERIAL OBSERVATION and the INDUSTRIAL/SPECIALIST categories.

\*\* The OTHER category combines RENTAL, COMMUTER AIR CARRIER and the original OTHER categories.

Source: Helicopter Forecasting Assessment and 1987 General Aviation Activity and Avionics Survey.

TABLE 46  
COMPARISON OF THE ESTIMATED ROTORCRAFT HOURS FLOWN BY  
PRIMARY USE CATEGORY FOR THE HFI AND GA SURVEYS

PRIMARY USE	1987 HFI SURVEY	1987 GA SURVEY	GA SURVEY MEAN 1983-1987
EXECUTIVE	117,556	230,836	400,600
BUSINESS	250,327	77,634	100,600
PERSONAL	49,622	46,714	40,800
INSTRUCTION	117,108	128,485	144,400
AERIAL APP.	262,315	229,960	210,200
WORK*	1,173,271	430,355	713,800
AIR TAXI	790,358	890,131	713,800
OTHER**	<u>113,129</u>	<u>249,011</u>	<u>545,200</u>
TOTAL	2,873,686	2,283,126	2,414,600

\* The WORK category combines the AERIAL OBSERVATION and the INDUSTRIAL/SPECIALIST categories.

\*\* The OTHER category combines RENTAL, COMMUTER AIR CARRIER and the original OTHER categories.

Source: Helicopter Forecasting Assessment and 1987 General Aviation Activity and Avionics Survey.

### 6.1.3 Hospital Aviation Survey

The magazine Hospital Aviation annually surveys hospital-based EMS operators and publishes the results of these surveys. Hospital Aviation reports survey responses on the order of 90 percent to many of its surveys. For purposes of this study, these survey results presented in Tables 17 and 18 are considered to be an accurate representation of hospital-based EMS operations and are used as a basis for estimating future hospital-based fleet size, flight hour and operational counts.

### 6.1.4 Offshore Survey Data

The Helicopter Safety Advisory Conference (HSAC) annually surveys the offshore helicopter community to determine the characteristics of the fleet, hours flown, and passengers carried. Although the survey varies from year to year, the results appear to be consistent and representative of factors known to affect offshore operations. Four years of HSAC operational data are presented in Table 20. These data were used as a basis for establishing future offshore fleet size, flight hour, and operational counts.

### 6.1.5 Scheduled Commuter Data

The scheduled commuter operations have been included as a part of the FAA General Aviation Activity and Avionics Survey since 1980. However, the helicopter scheduled commuter activity is so limited that the survey does not adequately represent this extremely small population. Standard error estimates from the FAA survey for this category often exceeds 50 percent and sometimes exceeds 100 percent of the expected results.

During the course of this investigation five scheduled commuter operations were identified. These operations used 18 helicopters (Table 6). These commuter operations represent most of those known to operate in the United States at the present time. Therefore this data was used as a basis to estimate the commuter fleet, flight hours, and operational counts.

### 6.1.6 ASI Forecast of Helicopter Operations

In the ASI report the expected helicopter fleet and flight hours were estimated based on economic factors. An intuitive analysis of these factors and the sign of the resulting multiplier was made as a sanity check on the forecast numbers. The helicopter forecasts were developed based on three factors, the relative cost of a helicopter to other costs, the total U.S. full-time employment, and the relative cost of oil and gas to other prices. The number of helicopters in use would be expected to increase with a decrease in the relative cost of helicopters. The number of helicopters would also be expected to increase with increasing employment as a sign of increasing wealth and U.S. economic viability. The number of helicopters would be expected to increase in the offshore and oil-industry related missions with an increase in oil and gas prices, however, helicopter use in other areas might decrease as high oil and gas prices would drive up operating costs of helicopters relative to more fuel efficient means of transportation.

Table 47 shows the sign of the multiplier for each factor for each of the primary use categories used by ASI. A positive sign indicates that the parameter will follow the economic factor while a negative sign indicates that the parameter will have the opposite trend.

TABLE 47  
COMPARISON OF HELICOPTER ESTIMATING FACTORS

		Relative Cost of Helicopter	Total U.S. Employment	Relative Cost of Oil and Gas	Trend Comparison
Expected Trend	Fleet	-	+	-	
	Hours	-	+	-	
PRIMARY USE					
Executive	Fleet	+	-	+	Opposite
	Hours	+	-	+	Opposite
Business	Fleet	-	+	-	Same
	Hours	-	+	-	Same
Personal	Fleet	-	+	-	Same
	Hours	-	+	-	Same
Instruction	Fleet	+	-	+	Opposite
	Hours	+	-	+	Opposite
Aerial Application	Fleet	-	+	+	Mixed
	Hours	-	+	+	Mixed
Air Taxi	Fleet	+	-	+	Opposite
	Hours	-	+	-	Same
Work	Fleet	+	+	+	Mixed
	Hours	-	+	+	Mixed
Other	Fleet	-	+	+	Mixed
	Hours	+	+	-	Mixed

Source: ASI Helicopter Forecasting Assessment, 1988.

The primary use categories of Business and Personal follow the expected trends as shown in Table 47. However, the Executive fleet and flight hours coefficients have the opposite sign from the expected value. This would indicate that as helicopter prices rise, more are bought and operated for executive use. Also as operating expenses rise, more helicopters are used for more flight hours. Neither of these trends can be explained fully. The increase in executive helicopters with relative cost might indicate that executives purchase and operate high-end sophisticated helicopters which is confirmed by Table 14. However, only oil- and gas-related corporations would be expected to have increased activity with rising oil and gas prices.

The Air Taxi fleet coefficients show the same trend as Executive. This could be explained by the fact that offshore air taxi operators use larger numbers of expensive, more sophisticated, large helicopters only when oil and gas prices rise above a trigger price. However, the same trends would not be the case for the majority of 14 CFR Part 135 operators in the rest of the United States.

No explanation for the increase of the Work fleet with increased helicopter cost and oil and gas price can be made. Similarly, the increase of "Other" helicopters with rising oil and gas prices cannot be explained.

Two possible reasons are presented to explain the behavior of the forecast equations. First, the historical data for component categories that are used to develop the forecast model exhibit large and unexplained variations on a year-to-year basis. This historical data could cause the model to be flawed. Second, the growth of the helicopter fleet and operational counts depend upon some factors that are not included in the economic model developed by ASI. In particular, the executive, business, scheduled commuter, and air taxi missions are affected by a lack of heliports in downtown central business district areas. This lack of heliports is caused more by sociological resistance to heliports rather than economic factors and is therefore not represented by the economic forecast models. Thus the model is potentially flawed by this omission.

Based on the analysis of the economic forecast model, it was determined that these models did not provide a suitable basis of likely helicopter forecast outcomes for several mission categories. Therefore this model was not selected for use in developing helicopter operational forecasts.

## 6.2 GROWTH RATE FORECAST MODEL

An alternative forecast model was developed using a best estimate of 1987 mission data as a current year start point followed by reasonable rates of growth or decline based on historical records and economic forecasts.

### 6.2.1 Estimates of Current Active Helicopters and Flight Hours

Estimates of current active helicopters and flight hours were developed from a combination of FAA general aviation survey results and industry provided surveys. Those mission categories that were used from the FAA general aviation survey were:

- Executive
- Business
- Air Taxi
- Aerial Observation (a subset of Work in the ASI report)

These estimates were calculated by averaging survey results from the last 4 years of data (1984-1987). The results for fleet and flight hour estimates are shown in Tables 48 and 49. In instances where the standard error of this average exceeded 15 percent, the yearly value with the greatest apparent error was dropped and a three year average was used

as the basis. High and low estimates for the starting points of the forecasts were based on adding or subtracting one standard error value from the mean value.

TABLE 48  
HELICOPTER FLEET AVERAGES 1984-1987

YEAR	EXECUTIVE	BUSINESS	AERIAL OBSERVATION	AIR TAXI	TOTAL
1984	1,035	541	840	1,504	7,096
1985	901	685	1,001	x	6,418
1986	1,010	644	969	1,381	6,943
1987	740	498	847	1,319	6,333
MEAN	922	592	914	1,401	6,698
STD. ERROR	116	75	72	77	328
STD ERROR (%)	12.6%	12.8%	7.8%	5.5%	4.9%

x - data omitted use to large variation

Source: FAA Statistical Handbook of Aviation.

TABLE 49  
HELICOPTER FLIGHT HOURS 1984-1987

YEAR	EXECUTIVE	BUSINESS	AERIAL OBSERVATION	AIR TAXI	TOTAL
1984	343,602	75,886	339,683	887,151	2,495,303
1985	306,144	x	x	x	2,154,617
1986	356,111	98,755	449,533	803,141	2,625,395
1987	x	77,634	360,348	890,131	2,283,126
MEAN	335,286	84,092	383,188	860,141	2,389,610
STD. ERROR	21,230	10,393	47,666	40,323	182,569
STD ERROR (%)	6.3%	12.4%	12.4%	4.7%	7.6%

x - data omitted use to large variation

Source: FAA Statistical Handbook of Aviation.

Estimate of EMS and offshore current operations were determined from industry survey results presented in Tables 17, 18, and 20. The estimates of current scheduled commuter operations were developed from discussions with known scheduled commuter helicopter operators as reported in Table 6.

#### 6.2.2 Estimates of Helicopter Growth Rate

A number of sources were reviewed in order to gain insight into both past and expected future growth of helicopter operations. These sources

included historical fleet size and flight hour forecasts from the FAA General Aviation Activity and Avionics Survey, forecasts from the FAA Aviation Forecasts, Fiscal Years 1988-1999, forecasts from the economic model in the ASI report, and forecasts from this same economic forecast model extended to the year 2007 for purposes of this study.

#### 6.2.2.1 Historical Growth Rate, 1977-1987

The growth rate of the helicopter fleet over the 10-year span from 1977-1987 was evaluated by calculating linear regression lines for the fleet size and hours flown data from the FAA General Aviation Activity and Avionics Survey. The slope of these regression lines were then equated to an annual growth rate. The results of this analysis showed annual growth rates of 2.68 percent for the helicopter fleet size and 1.27 percent for the helicopter hours flown. These rates appear to be quite reasonable as the growth of rotorcraft operations was quite rapid during the early part of this 10 year period due to rapid growth in offshore helicopter use. However, this growth fell off sharply as the energy problems of the 1970's abated in the 1980's. The difference in the growth rates for fleet size and hours flown indicates that some excess capacity exists in the current fleet as the average hours flown have decreased over the last 10 years.

#### 6.2.2.2 FAA Forecast Growth Rate

The FAA annually publishes forecasts of aviation activity. The two most recent publications are: FAA Aviation Forecasts Fiscal Years 1988-1999, published February 1988, and FAA Aviation Forecasts Fiscal Years 1989-2000, published March 1989. These reports will be referred to as the 1988 FAA forecast and the 1989 FAA forecast, respectively. Forecasts for rotorcraft fleet size and hours flown are contained in the reports. The average annual growth rates are:

<u>Report</u>	<u>Forecast Period</u>	<u>Average Growth Rate Per Year</u>	
		<u>Fleet Size</u>	<u>Hours Flown</u>
1988 FAA Forecast	1988-1999	1.9%	2.4%
1989 FAA Forecast	1989-2000	4.2%	5.1%

These forecasts are based on econometric models and time series analysis. The forecasts were developed by user category, and were added to obtain the national total. The model included factors related to the costs of owning a helicopter, total employment, and the cost of oil and gas relative to other prices. The 1989 forecast is considerably more aggressive than the 1988 forecast. Possible reasons for this are projected increases in oil and gas prices which will likely expand the offshore helicopter operations and optimistic economic projections.

#### 6.2.2.3 ASI 12-Year Forecast Growth Rate

The ASI report contains forecasts of the helicopter fleet size and hours flown for the years 1988-2000. These growth rates, based on economic factors, were calculated to be 3.67 percent for fleet size and 4.76 percent for hours flown. These growth rates are nearly as aggressive as those in the 1989 FAA forecast and are considerably more aggressive than those predicted by the 1988 FAA forecast and those seen in recent history.

#### 6.2.2.4 20-Year Forecast Growth Rate, 1987-2007

A 20-year economic forecast model of helicopter fleet size and hours flown, based on the economic model described in the ASI report, was developed to account for the full 20 years of helicopter operations which are of concern in the low altitude CNS study. However, rather than break the forecast effort into the component rotorcraft mission categories as was done by ASI, this analysis considered only the total helicopter fleet size and total helicopter hours flown. The model is based on three economic parameters which are assumed to influence helicopter operations directly; they are the cost of the helicopter relative to other prices, the U.S. full-time employment, and the cost of oil and gas relative to other prices, i.e., the same factors as used in the ASI report. The economic parameters contained in the ASI report were extended to year 2007 by determining the average annual growth rate over the period from 1988-2000 and extending these economic parameters for an additional 7 years at these rates.

The model was developed by using historic FAA fleet size and hours flown data over the years 1970-1987 and historic values of the economic parameters over the same period. These data were available in the ASI report. The model coefficients were calculated using least squares criteria and the resulting model produced forecast numbers that were very similar to the ASI forecast for the years 1988-2000.

The growth rates in helicopter fleet size and hours flown based on the 20-year model were 3.23 percent and 4.12 percent respectively.

#### 6.2.2.5 Summary of Growth Rates

Table 50 summarizes the four sources of growth rate data that were evaluated.

TABLE 50  
SUMMARY OF HELICOPTER FLEET SIZE AND HOURS  
FLOWN GROWTH RATES

<u>Source</u>	<u>Years</u>	<u>Annual Growth Rates</u>	
		<u>Fleet Size</u>	<u>Hours Flown</u>
FAA Historical (average of GA Survey)	1977-1987	2.68%	1.27%
FAA Forecast (1988)	1988-1999	1.90%	2.40%
FAA Forecast (1989)	1989-2000	4.20%	5.10%
ASI Forecast	1988-2000	3.67%	4.76%
20-Year Forecast	1988-2007	3.23%	4.12%

Based on a comparison of these growth rate values, a composite growth rate model for fleet size, termed the CNS Study Fleet Growth Model, was defined as:

Helicopter Fleet growth rate =  $2.7 \pm 1.0$  percent

Most likely fleet rate = 2.7 percent  
High estimate fleet rate = 3.7 percent  
Low estimate fleet rate = 1.7 percent

This range of growth rates encompasses both the optimistic forecast based on the economic models and the lower forecast of the FAA (1988). The higher forecast of the FAA (1989) appears to be very aggressive, therefore, the more conservative values were selected for the CNS Study Fleet Growth Model. The fleet growth values are shown in Figure 37.

Similarly, a total hours flown growth rate was established by comparing the five forecast sources for hours flown. This composite growth rate model, termed the CNS Study Flight Hours Growth Model, was defined as:

Helicopter Hours Flown growth rate =  $2.7 \pm 1.4$  percent

Most likely hours flown = 2.7 percent  
 High Estimate hours flown rate = 4.1 percent  
 Low Estimate hours flown rate = 1.3 percent

This growth rate range encompasses three of the five growth rate values from the analysis. The high growth rate values from the FAA forecast (1989) and the ASI model were considered to be more aggressive than would likely be warranted by the accompanying fleet growth rate. The other three forecast rates appeared to present an acceptable range of likely growth rates for the hours flown by helicopters. The flight hour rate values are shown in Figure 38.

### 6.3 HELICOPTER FLEET CHARACTERISTICS

#### 6.3.1 Helicopter Aircraft Type Estimates

Two estimates for the composition of the 1987 active helicopter fleet by aircraft type were made. The first was based on the data from Appendix D of the ASI report. This information on numbers of active helicopters by model was modified to include additional helicopters from the ASI database records (7 BV-107's, 1 BV-234) and the commuter operators survey (3 S-61's) yielding a total fleet estimate of 7,134. A second estimate of the composition of the active helicopter fleet was obtained from Table 2-5 of the General Aviation Activity and Avionics Survey for 1987. Table 51 compares the two estimates. These values encompass a slightly greater range than the one standard error value shown in Table 48.

#### 6.3.2 Helicopter Operations Estimates

Neither the FAA Statistical Handbook nor the General Aviation Activity and Avionics Survey contained operations estimates. Therefore the annual operations per helicopter estimated in Table 6 of the ASI report were used to calculate the operations for primary use missions. The following method was used:

Active Helicopters	x	Annual Operations	= Total Annual Operations
From Statistical		per Helicopter	
Handbook		from ASI Report	

Table 52 shows the results of these estimates.

FIGURE 37

# CNS STUDY FLEET GROWTH MODEL

COMPARISON OF ROTORCRAFT FLEET GROWTH RATE PREDICTIONS

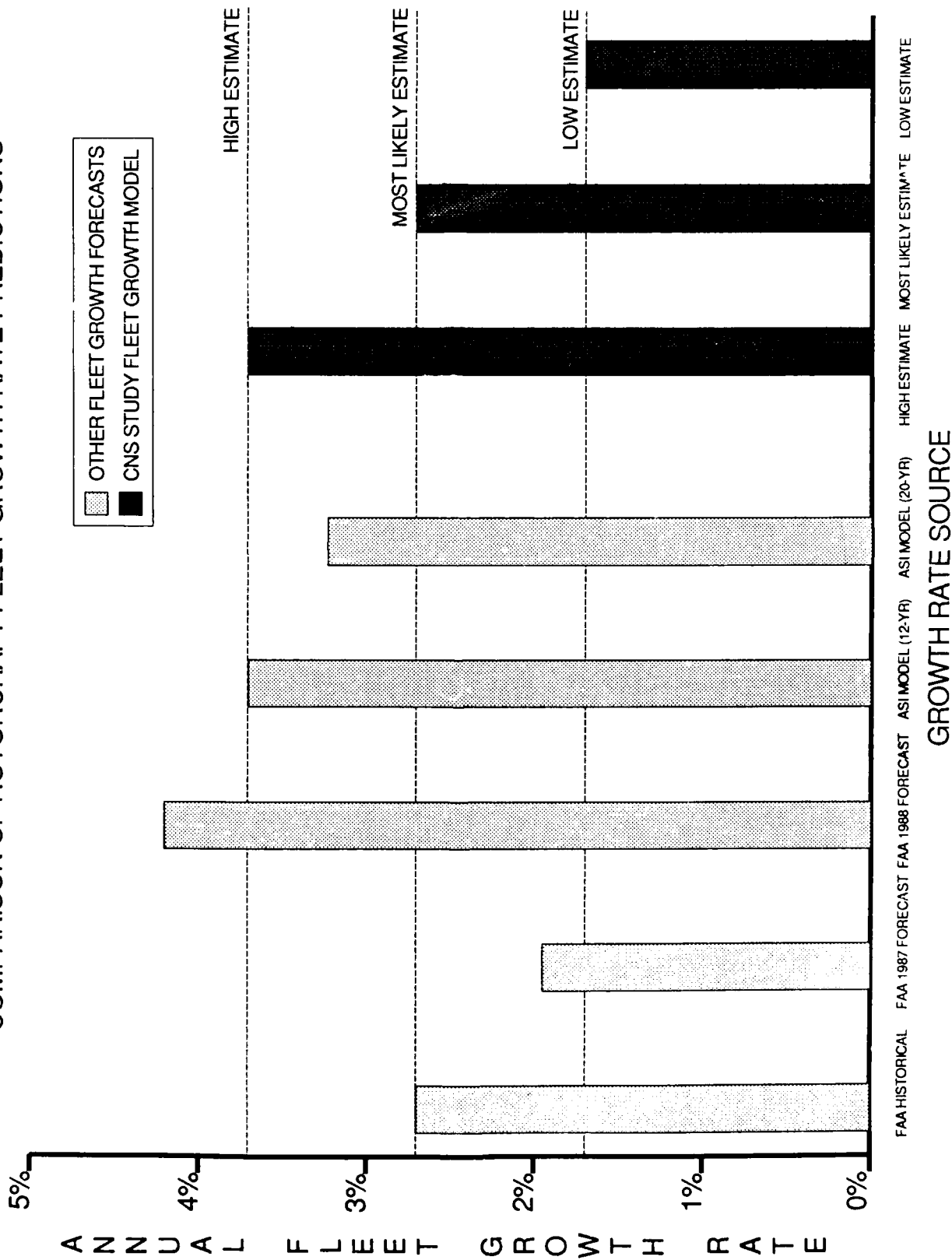
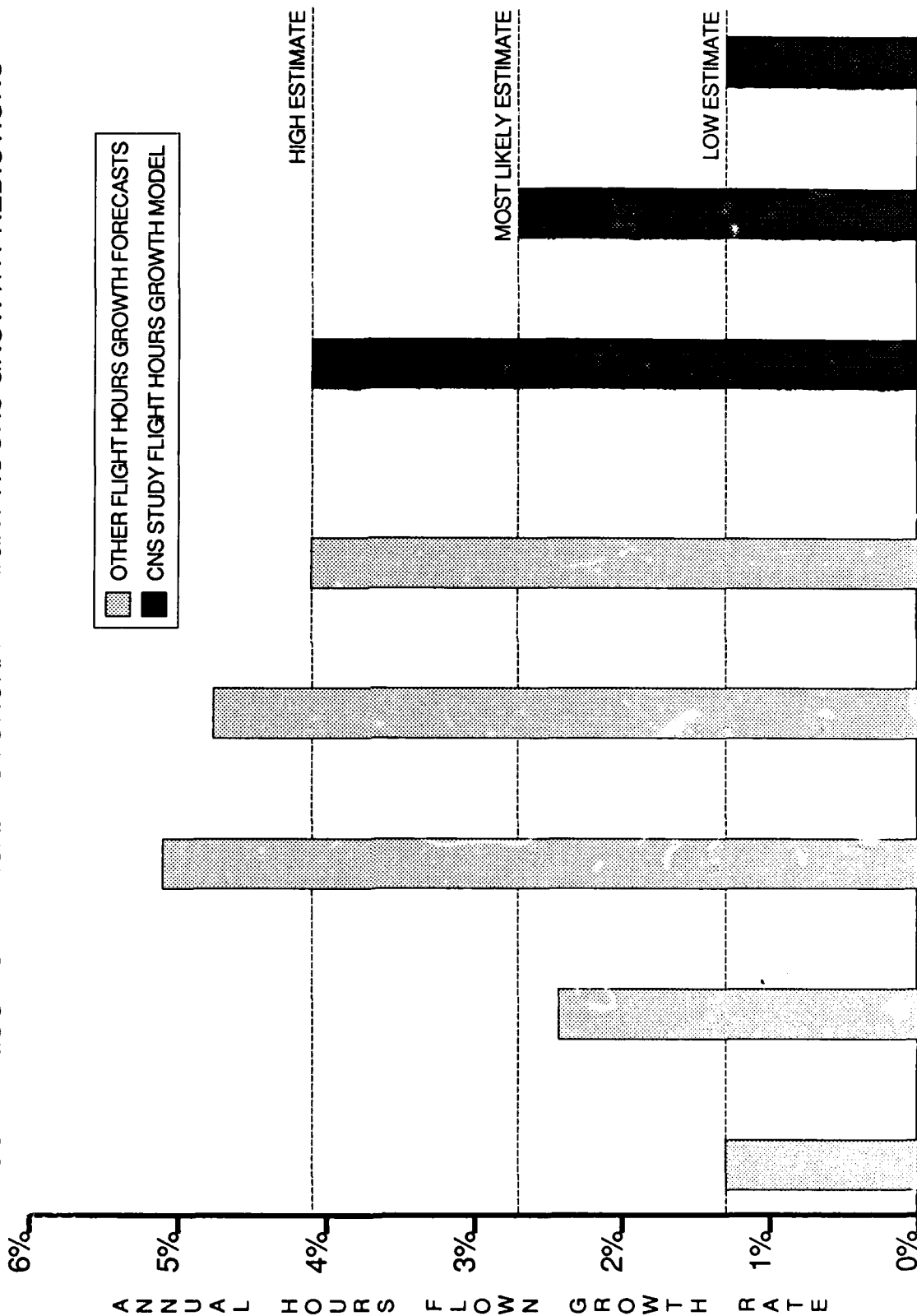


FIGURE 38

# **CNS STUDY FLIGHT HOURS GROWTH MODEL** COMPARISON OF ANNUAL ROTORCRAFT FLIGHT HOURS GROWTH PREDICTIONS



FAA HISTORICAL    FAA 1987 FORECAST    FAA 1988 FORECAST    ASI MODEL (12-YR)    ASI MODEL (20-YR)    HIGH ESTIMATE    MOST LIKELY ESTIMATE    LOW ESTIMATE

GROWTH RATE SOURCE

TABLE 51  
COMPARISON OF ESTIMATES OF ACTIVE HELICOPTERS  
GENERAL AVIATION AND AVIONICS SURVEY (GAAAS) AND ASI REPORT

MANUFACTURER	MODEL NO.	ASI ACTIVE ESTIMATE	GAAAS ACTIVE ESTIMATE
AEROSPATIALE	316	41	17
AEROSPATIALE	318	0	0
AEROSPATIALE	341	36	32
AEROSPATIALE	355	154	118
AEROSPATIALE	365	17	0
AEROSPATIALE	AS-350	239	0
AGUSTA	A109	59	38
AGUSTA	A205	0	16
BAG	B206	0	19
BELL	204, 205, UH-1	28	89
BELL	206A/B	1271	1723
BELL	206L	600	0
BELL	212	46	74
BELL	214ST	16	0
BELL	222	90	79
BELL	412	63	49
BELL	47	871	178
BOEING VERTOL	107	7	0
BOEING VERTOL	234	1	0
BRANTLY-HYNES	B2	106	36
ENSTROM	280	127	0
ENSTROM	F-28	326	318
HILLER	FH-1100	62	41
HILLER	UH-12	370	224
HILLER	H-23	0	26
MBB	BK-117	64	53
MBB	BO-105	95	112
MD/HUGHES	500	615	440
ORLANDO HELICOPTER	H-19	0	9
ORLANDO HELICOPTER	S-58	0	19
OTHER PISTON		91	728
OTHER TURBINE		444	160
ROBINSON	R-22	296	221
SCHWEIZER/HUGHES	269C	615	454
SCHWEIZER/HUGHES	TH-55	8	17
SIKORSKY	S-55	100	16
SIKORSKY	S-58	72	30
SIKORSKY	H-34	0	2
SIKORSKY	S-58T	26	19
SIKORSKY	S-61	5	13
SIKORSKY	S-76	173	137
UNKNOWN		0	226
TOTALS		7134	6333

Sources: General Aviation Activity and Avionics Survey and ASI Helicopter Forecasting Assessment.

TABLE 52  
ESTIMATED HELICOPTER OPERATIONS FOR 1987 BY PRIMARY USE

PRIMARY USE	FAA GA SURVEY HELICOPTERS	OPERATIONS PER HELICOPTER*	ANNUAL OPERATIONS
Aerial Application	756	2,869	2,169,000
Business	498	950	473,000
Executive	740	1,426	1,055,000
Instruction	314	541	170,000
Personal	835	354	296,000
Air Taxi	1,319	2,419	3,191,000
Aerial Observation**	847	1,339	1,134,000
Work	221	1,339	296,000
Other	793	2,133	1,691,000
Commuter**	9	2,133	19,000
Total	6,332		10,494,000

\* Source: ASI Helicopter Forecasting Assessment, 1988.

\*\* Included in the "Work" Category

\*\*\* Included in the "Other" Category

#### 6.4 FORECAST OF HELICOPTER MISSIONS

In this analysis the missions of interest are offshore, corporate/executive, scheduled commuter, EMS, search and rescue, and air taxi/commercial. The CNS Study Fleet Forecast Model described in Section 6.2 was used to determine the mission specific forecasts presented in this section.

##### 6.4.1 EMS

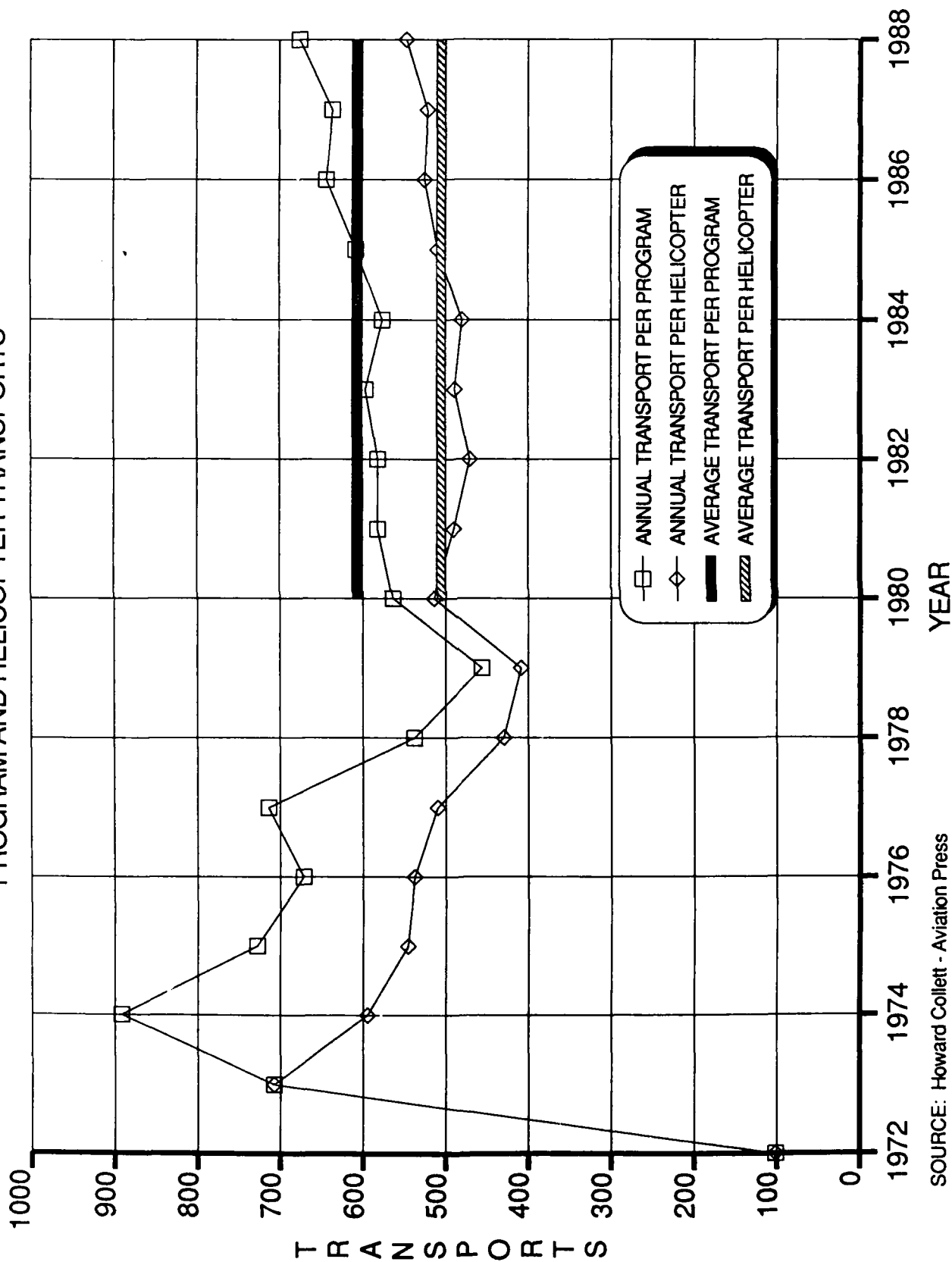
EMS was not a primary use category for the FAA General Aviation Survey. According to the definitions of FAA primary use categories, the EMS mission should be included as part of the "Other" category. However, comparing historic "other" data with EMS survey data yielded no apparent correlation. Therefore the EMS mission parameters were estimated based on published data from Hospital Aviation surveys.

EMS activity from historic data (Table 18) was examined for trends that would assist in forecasting future EMS missions. Figure 39 shows that while the EMS industry has experienced explosive growth, two ratios have been relatively constant since 1980. During this time, the average number of patient transfers per helicopter averaged 505 and the number of patient transfers per hospital-based program averaged 607. Since 1980, the average number of helicopters per hospital-based EMS program was 1.2. The average flight time per EMS mission from the Hospital Aviation survey of 1987 was 1.05 hours. Using this information, estimates of helicopters, flight hours, and number of patient transfers were made.

FIGURE 39

# EMS INDUSTRY TRENDS

## PROGRAM AND HELICOPTER TRANSPORTS



SOURCE: Howard Collett - Aviation Press

#### 6.4.1.1 EMS Flight Hours

Estimates of EMS flight hours were based on the estimated EMS fleet developed in 6.4.1.2 below. Using the average number of transfers per helicopter from the historic data and the average flight length per transfer, EMS hours flown can be calculated by:

Number of Transfers per helicopter = 505

Flight hours per transfer = 1.05

Therefore, Transfer Flight Hours = 1.05 X 505 X Number of Helicopters

To estimate total EMS flight hours the number of flight hours spent in other EMS activity such as training, repositioning the aircraft, fueling and maintenance flights, promotional flights, etc., was added to the transfer flight hours. Discussions with EMS operators established ranges from 10 percent to 20 percent based on the maturity of the program. A value of 15 percent was selected for non-transfer related flight activity.

Figure 40 shows the most likely, high and low estimates of EMS hours flown.

#### 6.4.1.2 EMS Fleet Size

Figure 41 shows EMS fleet size. The basis of the EMS fleet was determined from Table 17 which shows 199 helicopters associated with hospital-based EMS programs in 1988. To this number of helicopters was added 20 helicopters for non-hospital-based EMS programs. This value was derived from a Hospital Aviation survey from October 1987 which listed 16 non-hospital-based operators flying approximately 40 helicopters. Two operators had no specific number of helicopters listed, only the term "various." Half of these 40 helicopters were assumed to be primarily used for EMS. This is about 10 percent of the total EMS fleet. The remainder had various other responsibilities including law enforcement, search and rescue, employee transportation, etc. A 5 percent survey error was assumed to derive high and low estimates. The resulting starting point for forecasted 1989 EMS operations is therefore:

Most likely EMS fleet estimate	= 219 helicopters
High estimate	= 230 helicopters
Low estimate	= 208 helicopters

The rate of growth of EMS industry has been explosive over the last several years with growth rates ranging from 24 percent to 50 percent per year. It is believed that this market is beginning to mature and that growth rates will move downward significantly over the next several years, but growth rates will continue well above the average for the helicopter industry. Based on this assumption, three growth rate scenarios were developed for EMS helicopters for the next 20 years. These rates and the number of helicopters are shown in Table 53.

# FLIGHT HOUR FORECASTS

FIGURE 40

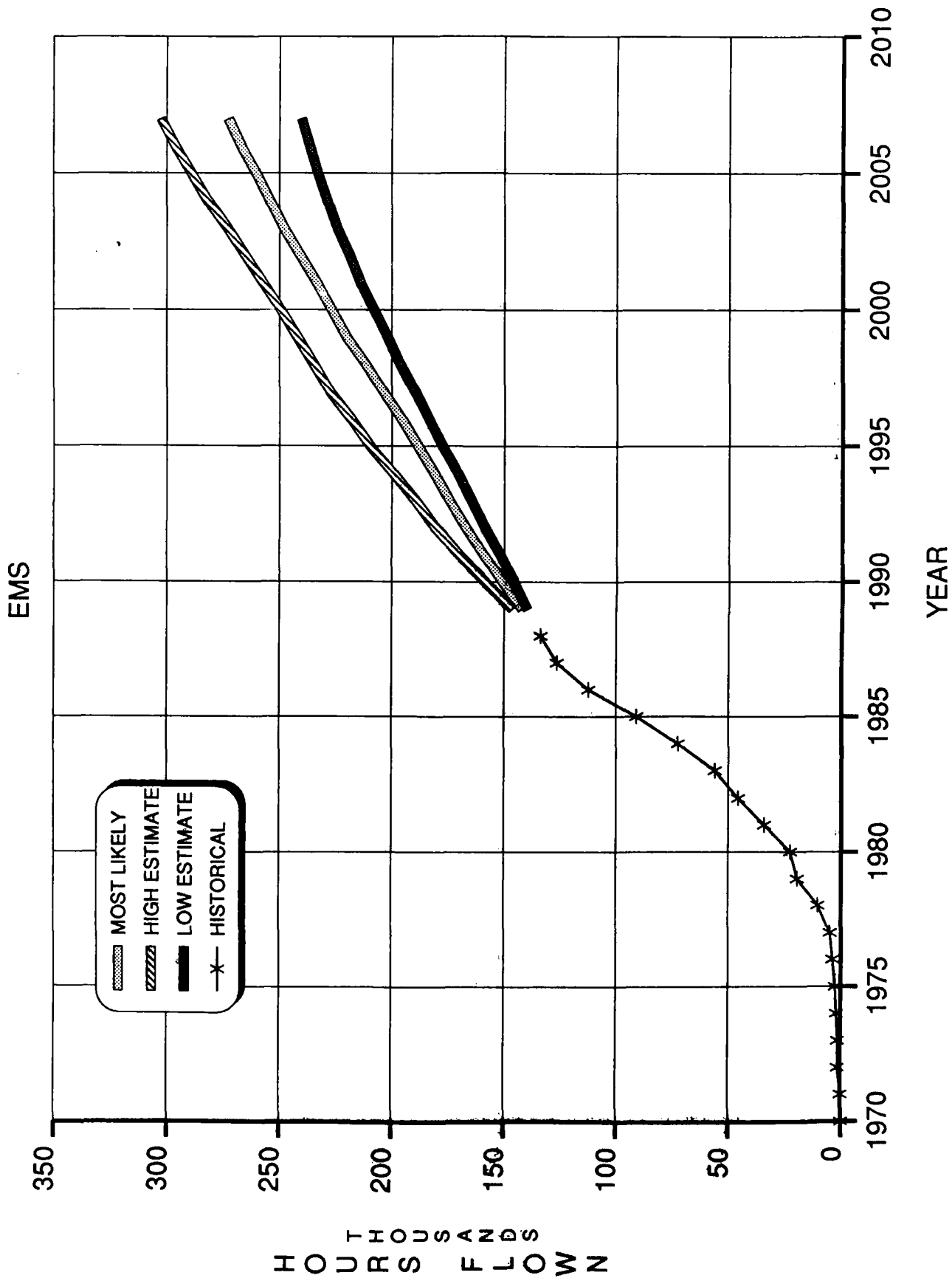


FIGURE 41

# FLEET FORECASTS

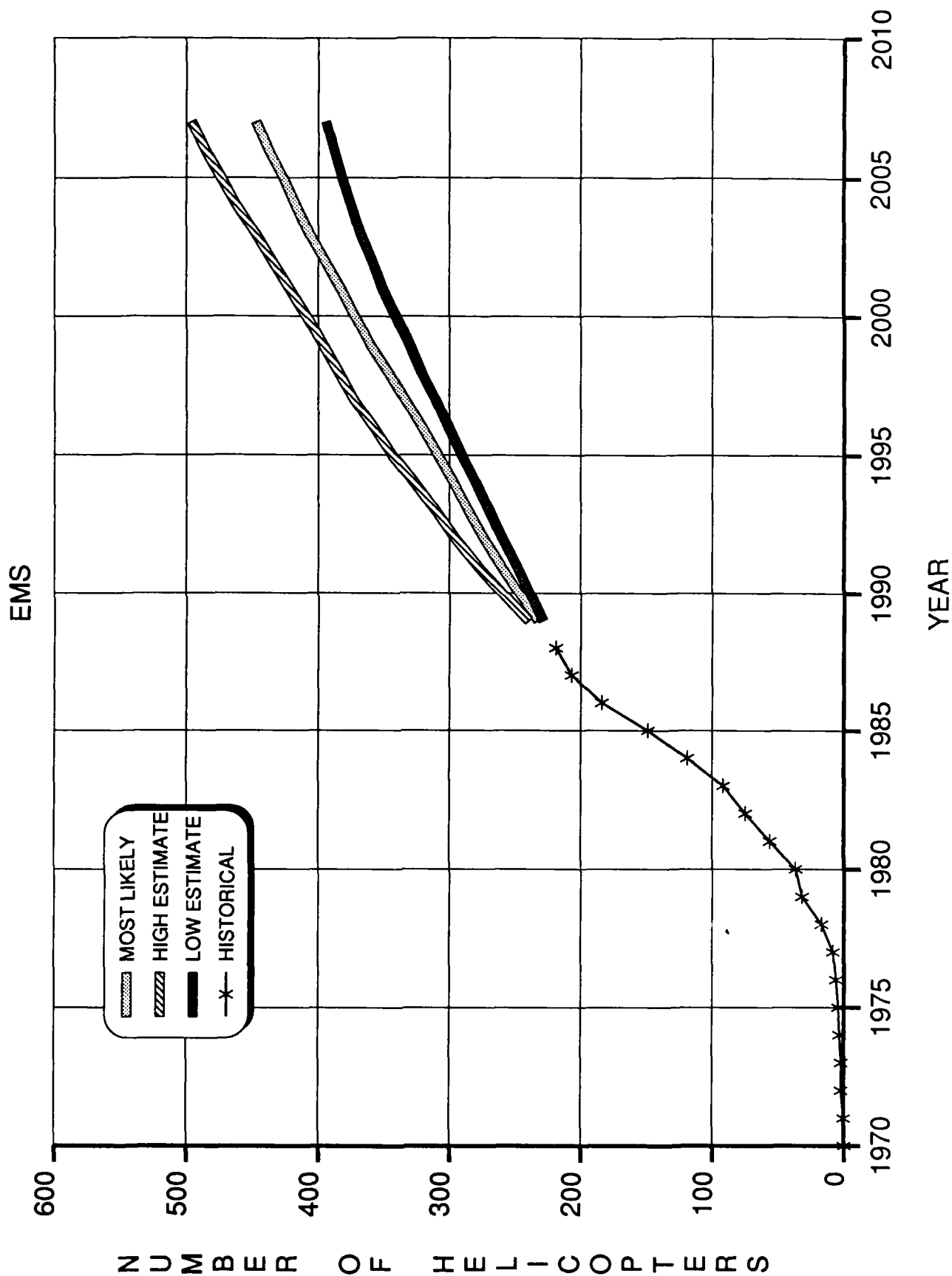


TABLE 53  
ESTIMATED ADDITIONAL EMS HELICOPTERS PER YEAR, 1988-2007

Year	Most Likely		High Estimate		Low Estimate	
	No.	%	No.	%	No.	%
1989	14	6.5%	21	9.0%	10	5.0%
1990	14	6.0%	20	8.0%	10	4.5%
1991	14	5.5%	19	7.0%	10	4.5%
1992	13	5.0%	17	6.0%	11	4.5%
1993	12	4.5%	15	5.0%	10	4.0%
1994	11	4.0%	16	5.0%	10	4.0%
1995	12	4.0%	17	5.0%	11	4.0%
1996	12	4.0%	14	4.0%	10	3.5%
1997	13	4.0%	15	4.0%	10	3.5%
1998	13	4.0%	12	3.0%	11	3.5%
1999	14	4.0%	12	3.0%	9	3.0%
2000	11	3.0%	12	3.0%	10	3.0%
2001	11	3.0%	13	3.0%	10	3.0%
2002	12	3.0%	13	3.0%	8	2.5%
2003	12	3.0%	13	3.0%	9	2.5%
2004	10	2.5%	14	3.0%	7	2.0%
2005	10	2.5%	12	2.5%	7	2.0%
2006	11	2.5%	12	2.5%	6	1.5%
2007	9	2.0%	10	2.9%	6	1.5%

#### 6.4.1.3 EMS Operations

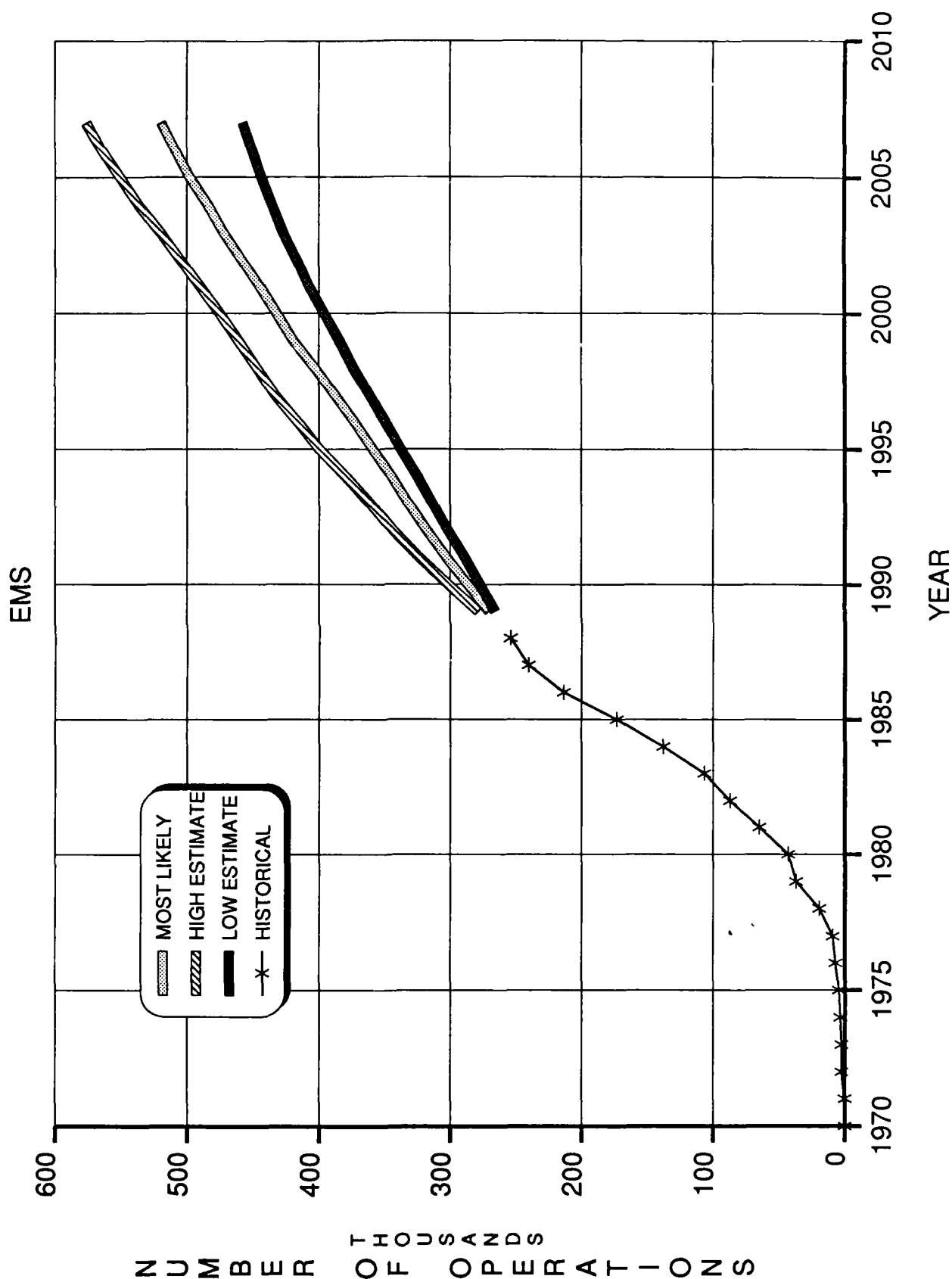
EMS operations were estimated by multiplying the number of active helicopters from the EMS helicopter fleet estimates in 6.4.1.2 by the average number of transfers per EMS helicopter per year (505) and the number of operations per transfer. It was assumed that each transfer required two operations to complete the mission, one with the patient on board and one to position the aircraft. An additional 15 percent was added to the EMS operations forecast to account for EMS related operations that are not related to patient transport. Figure 42 shows the estimated patient transfers and historic data.

#### 6.4.1.4 EMS Operating Area

The operating area for EMS is expected to increase to the point that substantial portions of the continental United States are provided helicopter EMS. However, the main concentration of helicopter EMS operations will follow demographic patterns and be located in and around urban and suburban areas.

FIGURE 42

# OPERATIONS FORECASTS



#### 6.4 <sup>2</sup> Corporate/Executive

##### 6.4.2.1 Corporate/Executive Flight Hours

The starting point for the forecast of the corporate/executive helicopter flight hours was taken from Table 49. The mean flight hours in the executive category was used as the most likely forecast of 1988 corporate/executive flight hours. This value was adjusted by one standard error value to obtain high and low estimates of corporate/executive flight hours. The results for 1988 are:

Most likely flight hour estimate	= 335,286 hours
High estimate	= 356,516 hours
Low estimate	= 314,056 hours

The growth rate for corporate/executive flight hours was assumed to follow the growth rate pattern of the overall helicopter flight hours as presented in Section 6.2.2.5, these rates are:

Most likely flight hour rate	= 2.7 percent per year
High estimate	= 4.1 percent per year
Low estimate	= 1.3 percent per year

Figure 43 presents the resulting flight hour forecasts, historical FAA survey data, and the ASI forecast for corporate/executive helicopters.

##### 6.4.2.2 Corporate/Executive Fleet Size

The starting point for the forecast of the corporate/executive fleet size was taken from Table 48. The mean fleet size in the executive category was used as the most likely forecast of the 1988 corporate/executive fleet size. This value was adjusted by one standard error value to obtain high and low estimates of the corporate/executive fleet size. The results for 1988 are:

Most likely fleet size estimate	= 922 helicopters
High estimate	= 1,038 helicopters
Low estimate	= 806 helicopters

The growth rate for the corporate/executive fleet size was assumed to follow the growth rate pattern of the total helicopter fleet as presented in Section 6.2.2.5. These rates are:

Most likely fleet size rate	= 2.7 percent per year
High estimate	= 3.7 percent per year
Low estimate	= 1.7 percent per year

Figure 44 presents the resulting fleet size forecasts, historical FAA survey data and the ASI forecast for corporate/executive helicopters.

##### 6.4.2.3 Corporate/Executive Operations

Corporate/executive operations were determined from the corporate/executive fleet size, Figure 44, and the estimated annual operations per helicopter from Table 52. For corporate/executive helicopters this factor is 1,426 operations per helicopter per year. The resulting estimated annual operations are shown in Figure 45.

Figure 43

# FLIGHT HOUR FORECASTS

CORPORATE/EXECUTIVE

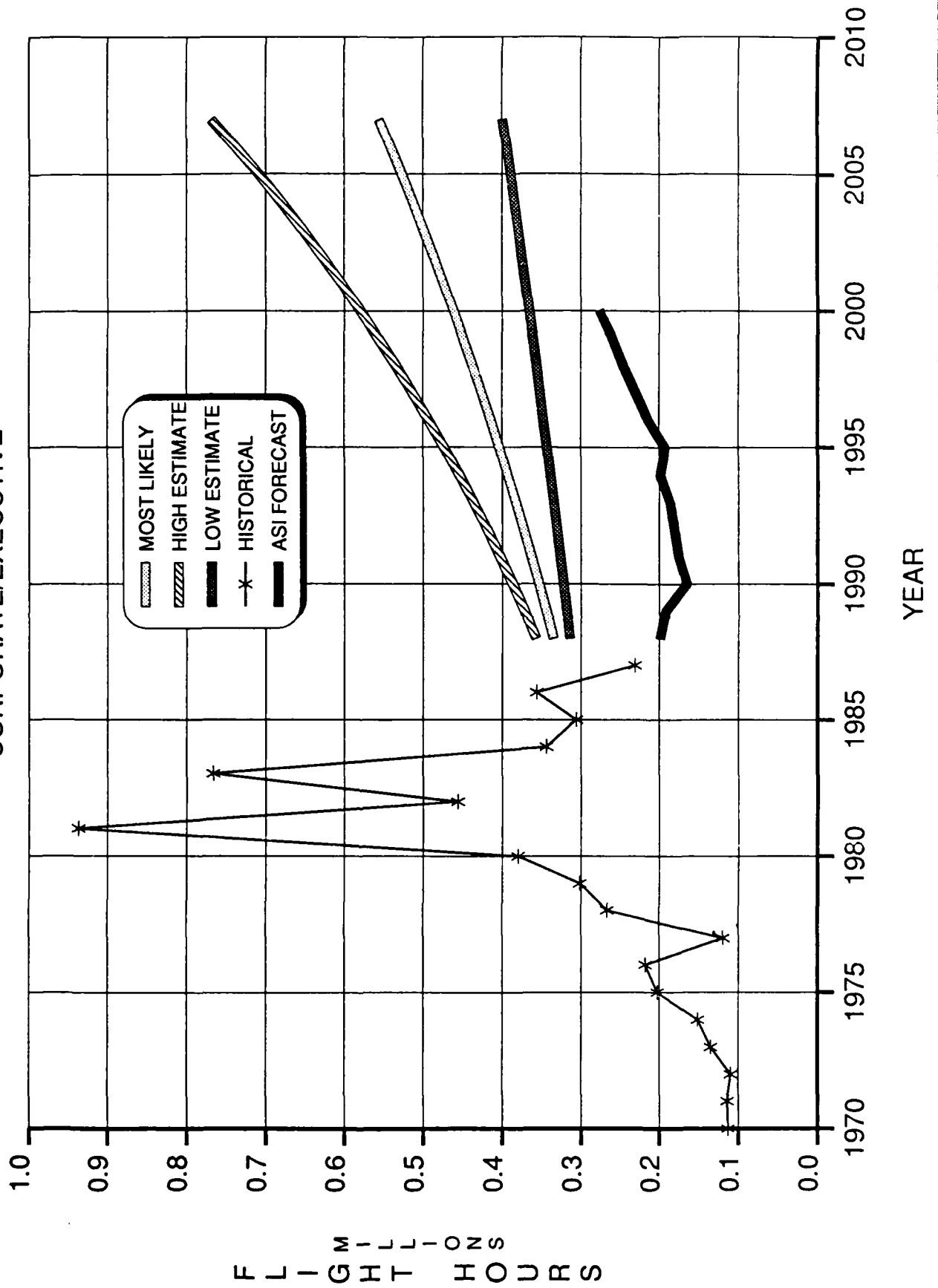


Figure 44

# FLEET FORECASTS

CORPORATE/EXECUTIVE

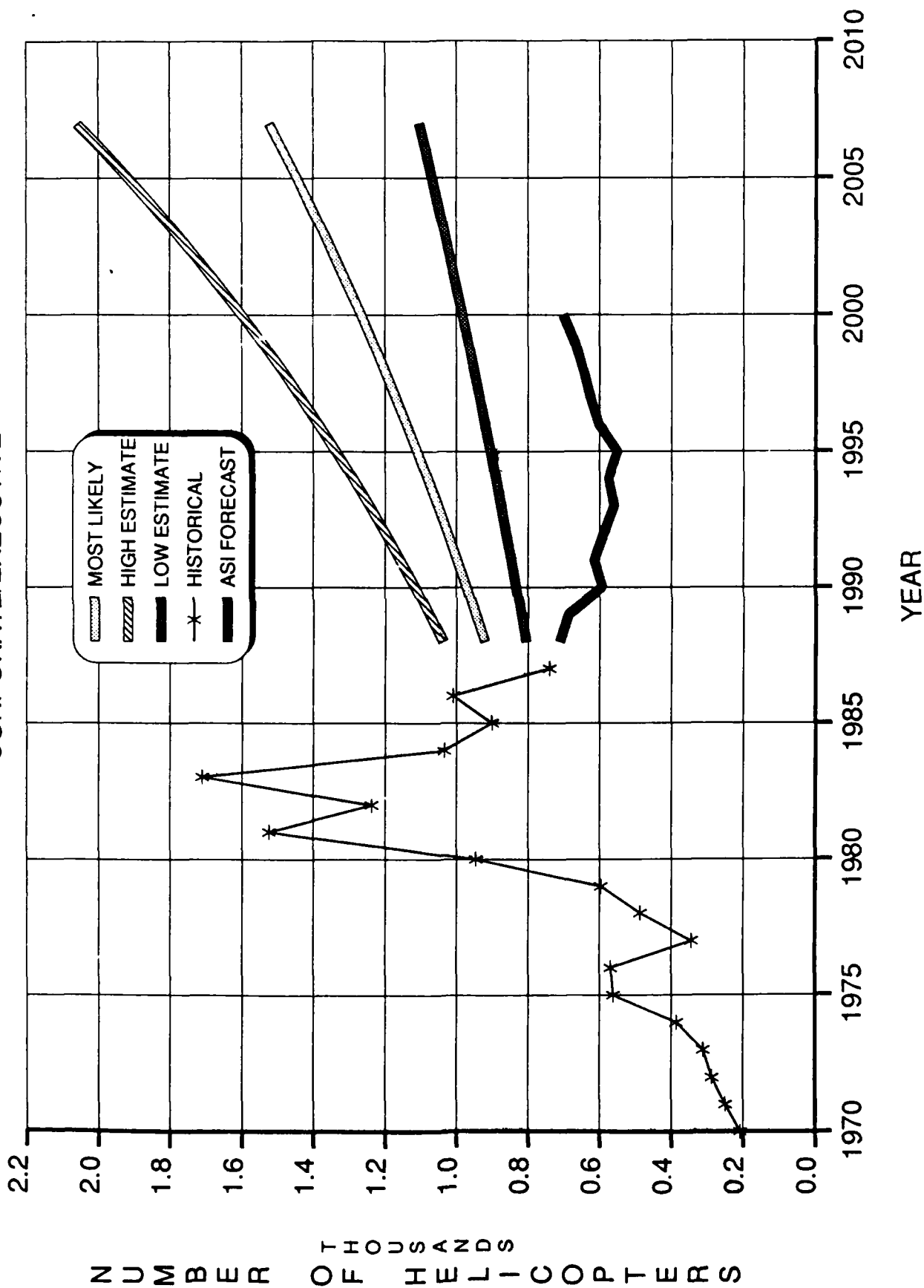
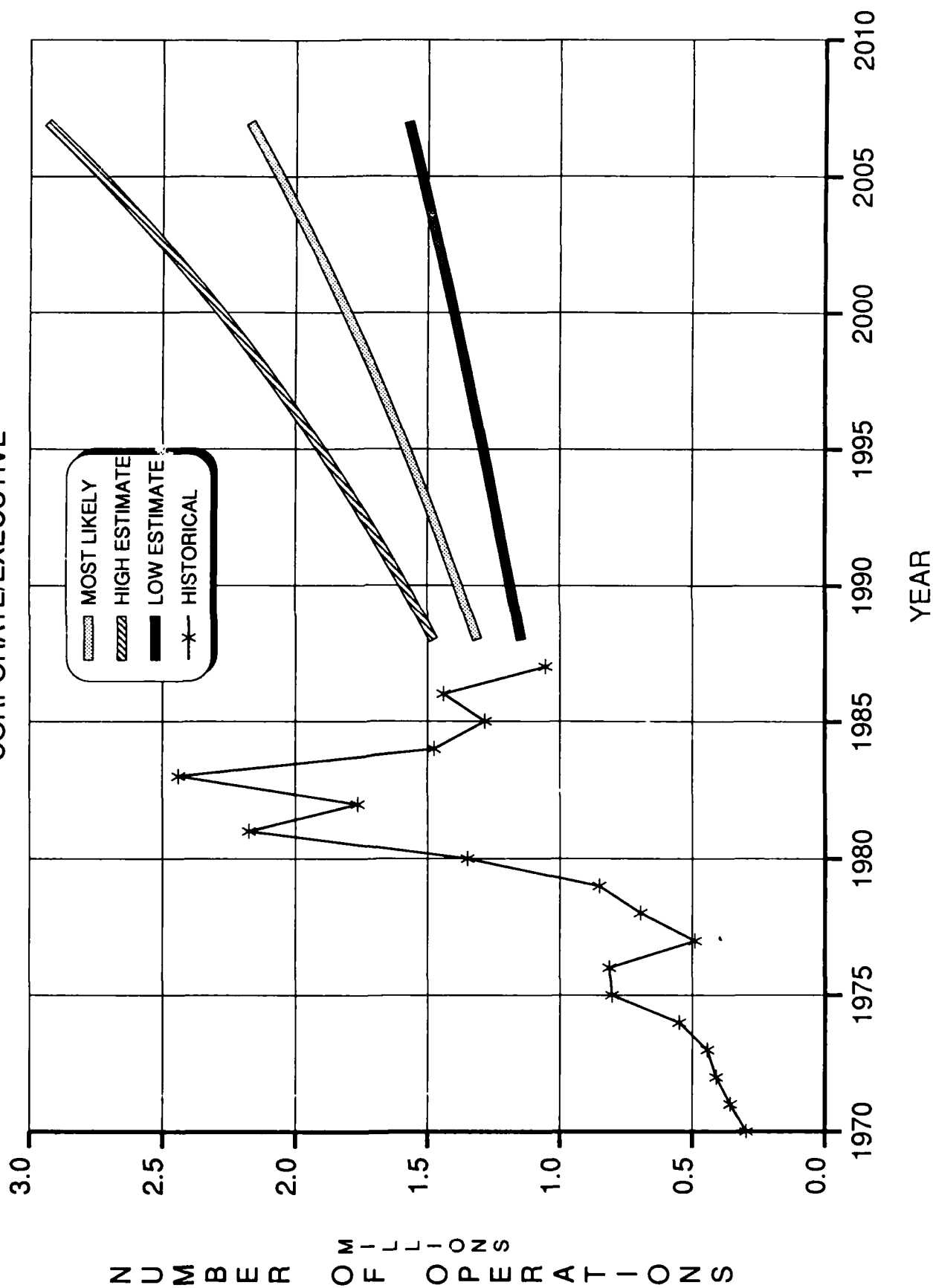


Figure 45

# OPERATIONS FORECASTS

CORPORATE/EXECUTIVE



#### 6.4.2.4 Corporate/Executive Operating Area

Although significant numbers of Part 91 operators exist in the west and southwest, the majority of corporate/executive operations are expected to remain in the northeast United States.

#### 6.4.3 Scheduled Commuter

The helicopter scheduled commuter mission is so small that survey results are highly variable and quite unreliable. Standard error estimates for this category in the FAA General Aviation Activity and Avionics Survey often exceed 50 percent and sometimes exceed 100 percent. An alternative approach for establishing a basis for this mission category was developed. Through discussions with industry representatives, five scheduled commuter operators were identified. These operators were using a total of 18 helicopters (Table 6). It is quite possible that some operations were missed. Therefore the 18 known helicopters were considered to be the low estimate and the standard error was estimated to be between 20 percent - 25 percent or 4 helicopters.

##### 6.4.3.1 Scheduled Commuter Flight Hours

Scheduled commuter operations typically have high aircraft utilization. An average aircraft utilization rate of 750 hours per year was assumed with a standard error of 20 percent. These assumed rates were applied to the most likely fleet size estimate for 1988 contained in section 6.4.3.2.

Most likely flight hour estimate	= 16,500 hours
High estimate	= 19,800 hours
Low estimate	= 13,200 hours

The growth rate for scheduled commuter flight hours is very difficult to evaluate due to the small size of the category. Therefore, a large range of growth rates were used for this mission category. The most likely growth rate was set at one point above the total helicopter flight hour growth rate. The high estimate was set at two points above and the low estimate was assumed to equal the total helicopter flight hour growth rate.

Most likely flight hour growth rate	= 3.7 percent per year
High estimate	= 6.1 percent per year
Low estimate	= 1.3 percent per year

The scheduled commuter flight hour estimates are shown in Figure 46.

##### 6.4.3.2 Scheduled Commuter Fleet Size

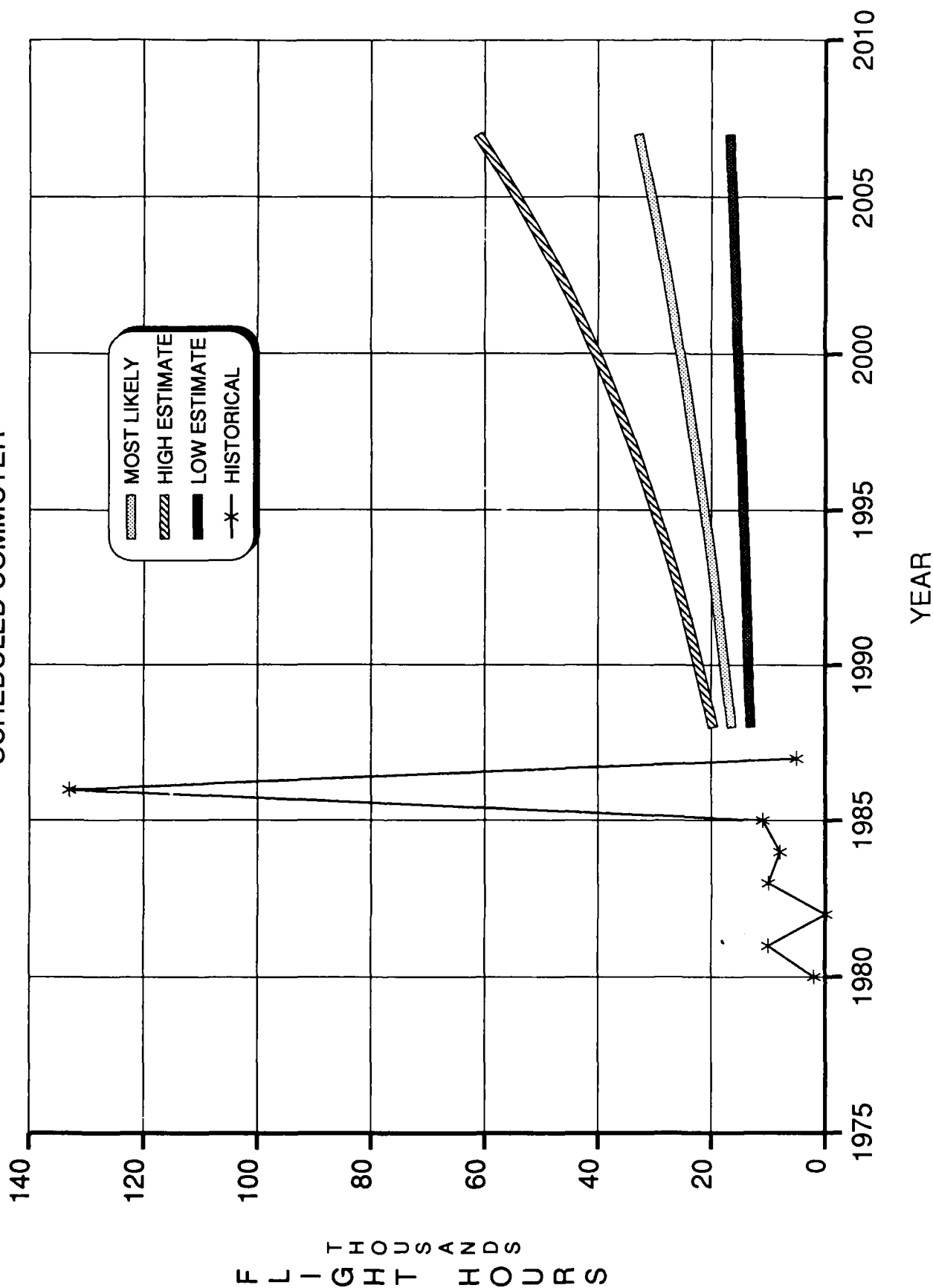
Based on known current scheduled commuter operations, the following fleet basis for 1988 was established:

Most likely fleet size estimate	= 22 helicopters
High estimate	= 26 helicopters
Low estimate	= 18 helicopters

Figure 46

# FLIGHT HOUR FORECASTS

SCHEDULED COMMUTER



The most likely growth rate estimate for the scheduled commuter fleet was set at one point above the total helicopter fleet growth rate. The high estimate was set at two points above the total helicopter fleet growth rate, and the low estimate was assumed to be the same as the total helicopter fleet growth rate. This large range of growth rates represents the degree of growth rate potential for this mission.

Most likely fleet growth rate	= 3.7 percent per year
High estimate	= 5.7 percent per year
Low estimate	= 1.7 percent per year

Figure 47 shows the resulting estimates of the scheduled commuter fleet.

#### 6.4.3.3 Scheduled Commuter Operations

Scheduled commuter operations are determined from the scheduled commuter fleet size, Figure 47, and the estimated annual operations per helicopter from Table 52. Scheduled commuters are contained in the "Other" primary mission category in the ASI report. This factor is 2,133 operations per helicopter per year. The estimated annual operations calculated using this factor are shown in Figure 48.

#### 6.4.3.4 Scheduled Commuter Operating Areas

Commuter operations are expected to continue to be located in large urban areas where there are congested conventional transportation modes. Additional operators will probably establish service first in those cities which previously had helicopter passenger service. Advanced rotorcraft designs may lead to expansion of the current predominantly intra-city routes to intercity service, particularly in the northeast United States.

#### 6.4.4 Offshore

##### 6.4.4.1 Offshore Flight Hours

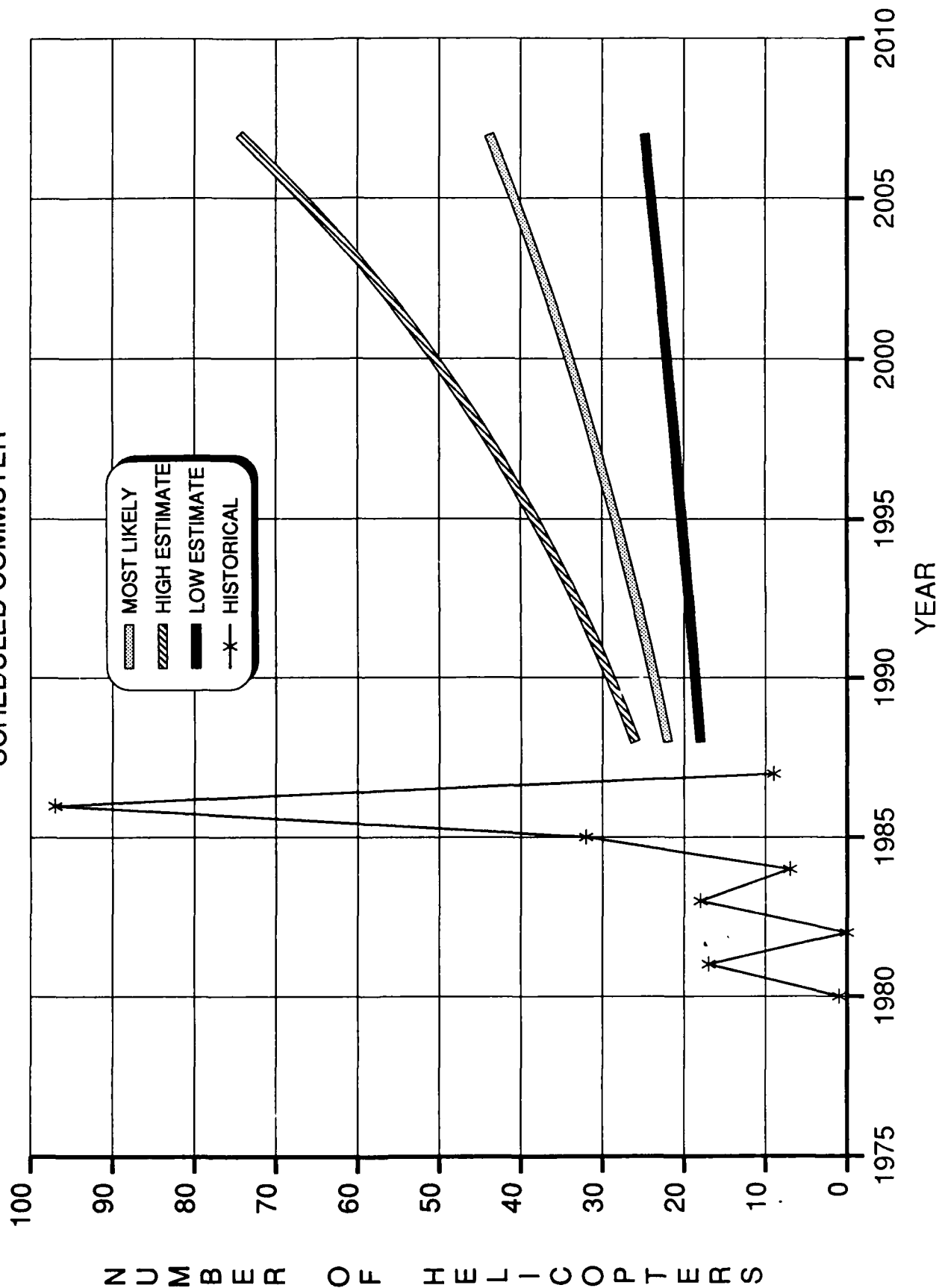
According to the definitions of the FAA primary use categories, offshore flight hours could be reported as either business or air taxi depending upon whether the helicopter was operated under 14 CFR Part 91 or 14 CFR Part 135, respectively. However, examination of the total flight hours for business and air taxi for the years 1984-1987 (published in Table 13 of the ASI report) reveals that offshore flight hours reported by operators in the HSAC survey (Table 20) exceed the total business flight hours in every case. The HSAC offshore flight hours are less than the total air taxi flight hours for every year except 1985. Therefore the offshore flight hours will be estimated as a percentage of total air taxi hours and no distinction will be made between 14 CFR Part 91 and 14 CFR Part 135 offshore operators.

The basis for the offshore forecast is the data from the 1987 HSAC survey shown in Table 20. The reported flight hours for 1987 were

Figure 47

# FLEET FORECASTS

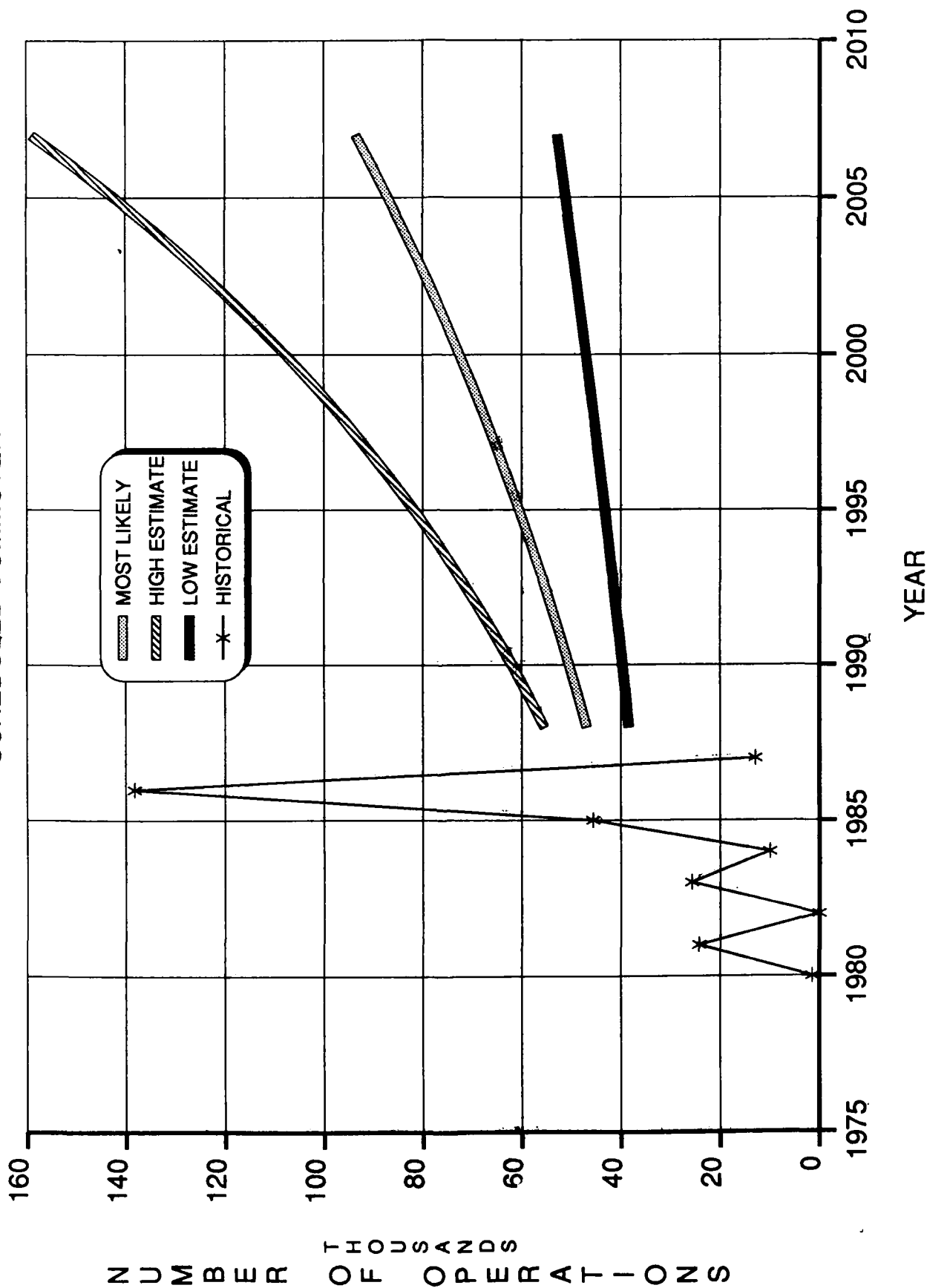
SCHEDULED COMMUTER



# OPERATIONS FORECASTS

Figure 48

SCHEDULED COMPUTER



455,330. This value was used as the most likely estimate. A survey standard error of 10 percent was assumed and used to determine the high and low flight hour estimates.

Most likely flight hour estimate	= 455,330 hours
High estimate	= 500,863 hours
Low estimate	= 409,797 hours

The growth rate for offshore flight hours declined steeply during 1987 after being relatively stable during the three prior years. The relative cost of gas and oil, an index used in the ASI economic forecast model, shows a strong upward trend over the next several years. This would seem to indicate a likely recovery of the offshore petroleum industry which in turn should improve the outlook for the offshore helicopter operators. To reflect the recent weakness in offshore operations, the growth rate for offshore flight hours was assumed to grow at the same rate as the total helicopter flight hours through 1995. To reflect the expected upturn in the petroleum industry, the growth rate was assumed to increase by one point for the years 1996-2007 for the most likely and high estimates. The low estimate assumed that the offshore flight hour growth rate would match the low estimate of total helicopter rate at all times.

Most likely flight hour growth rate	= 2.7 percent per year (1988-1995)
	= 3.7 percent per year (1996-2007)
High estimate	= 4.1 percent per year (1988-1995)
	= 5.1 percent per year (1996-2007)
Low estimate	= 1.3 percent per year (1988-2007)

The resulting offshore flight hour estimates are shown in Figure 49.

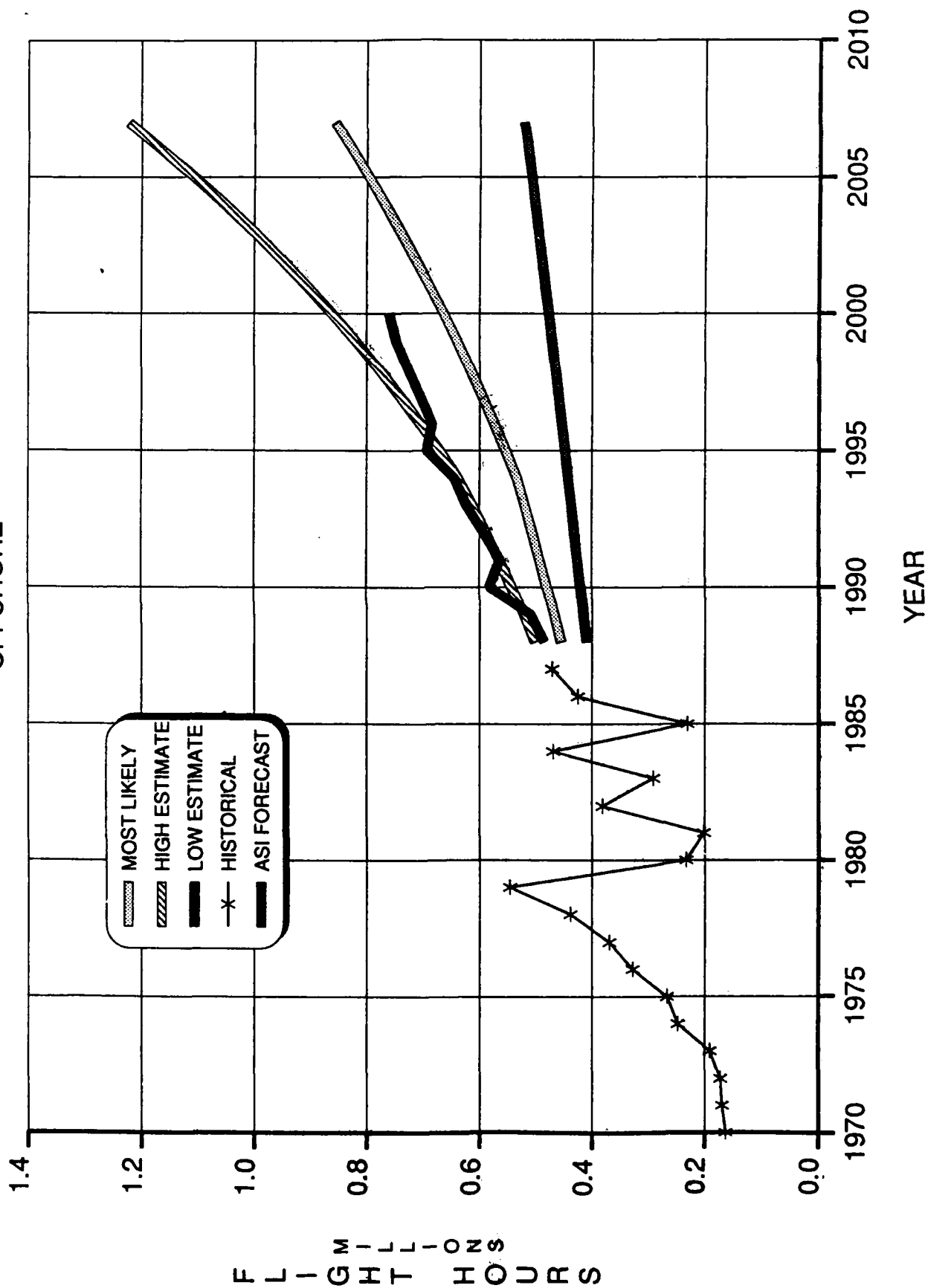
#### 6.4.4.2 Offshore Fleet Size

The basis for the offshore fleet is the data from the 1987 HSAC survey contained in Table 20. The reported offshore active fleet for 1987 was 599 helicopters. Note that fleet data are available for 1988 but other categories of data were not yet recorded. For this reason, the 1987 results were used as a basis for the forecast. Again, as with the flight hour data, the survey results were assumed to have a 10 percent standard error.

Most likely fleet size estimate	= 599 helicopters
High estimate	= 659 helicopters
Low estimate	= 539 helicopters

The growth rate for the offshore fleet was assumed to have the same characteristics as the flight hour rate. The growth rate follows the total helicopter rate through 1995 and then increases by one point in years 1996-2007 to reflect increased demand for petroleum resources. This pattern was used for the most likely rate and the high estimate.

# Figure 49 OFFSHORE FLIGHT HOUR FORECASTS



The low estimate was assumed to be the same as the low estimate for the total helicopter fleet.

Most likely fleet growth rate	= 2.7 percent per year (1988-1995) = 3.7 percent per year (1996-2007)
High estimate	= 3.7 percent per year (1988-1995) = 4.7 percent per year (1996-2007)
Low estimate	= 1.7 percent per year (1988-2007)

The resulting offshore fleet estimates are shown in Figure 50.

#### 6.4.4.3 Offshore Operations

Offshore operations were determined from the offshore fleet size, Figure 50, and the estimated annual operations per helicopter from Table 6 of the ASI report. Offshore operational data are included in the air taxi category in this report. For air taxi helicopters, the operations factor is 2,419 operations per helicopter per year. The resulting estimated annual offshore operations are shown in Figure 51.

#### 6.2.4.4 Offshore Operating Areas

Offshore operations are expected to continue throughout the active lease areas shown in Figures 33 and 34. Increasing demand for oil and gas and the need to show activity to maintain current leases may cause exploration in more distant currently inactive lease areas.

#### 6.4.5 Search and Rescue

According to Table 5, search and rescue, missions are a portion of the aerial observation primary use category. This category has been surveyed separately from the work primary use category since 1980. The ASI report combines aerial observation into the work category.

In order to distinguish search and rescue missions from other aerial observation missions, the data from the HFI survey was reviewed in detail. In this survey the law enforcement/search and rescue mission was counted separately from other aerial observation and work categories. In this survey the law enforcement/search and rescue fleet was 54.4 percent of the aerial observation fleet and the law enforcement/search and rescue flight hours were 64.0 percent of the total aerial observation flight hours.

Helicopters used for search and rescue activities are often used for other law enforcement activities as well. Therefore search and rescue is not considered a primary use category for most operators. It was assumed that all helicopters in the law enforcement/search and rescue category are used for search and rescue purposes sometime during an average year. Further, it was assumed that the search and rescue flight hours were only a small percentage of the overall law enforcement/search and rescue flight hours.

# Figure 50 FLEET FORECASTS OFFSHORE

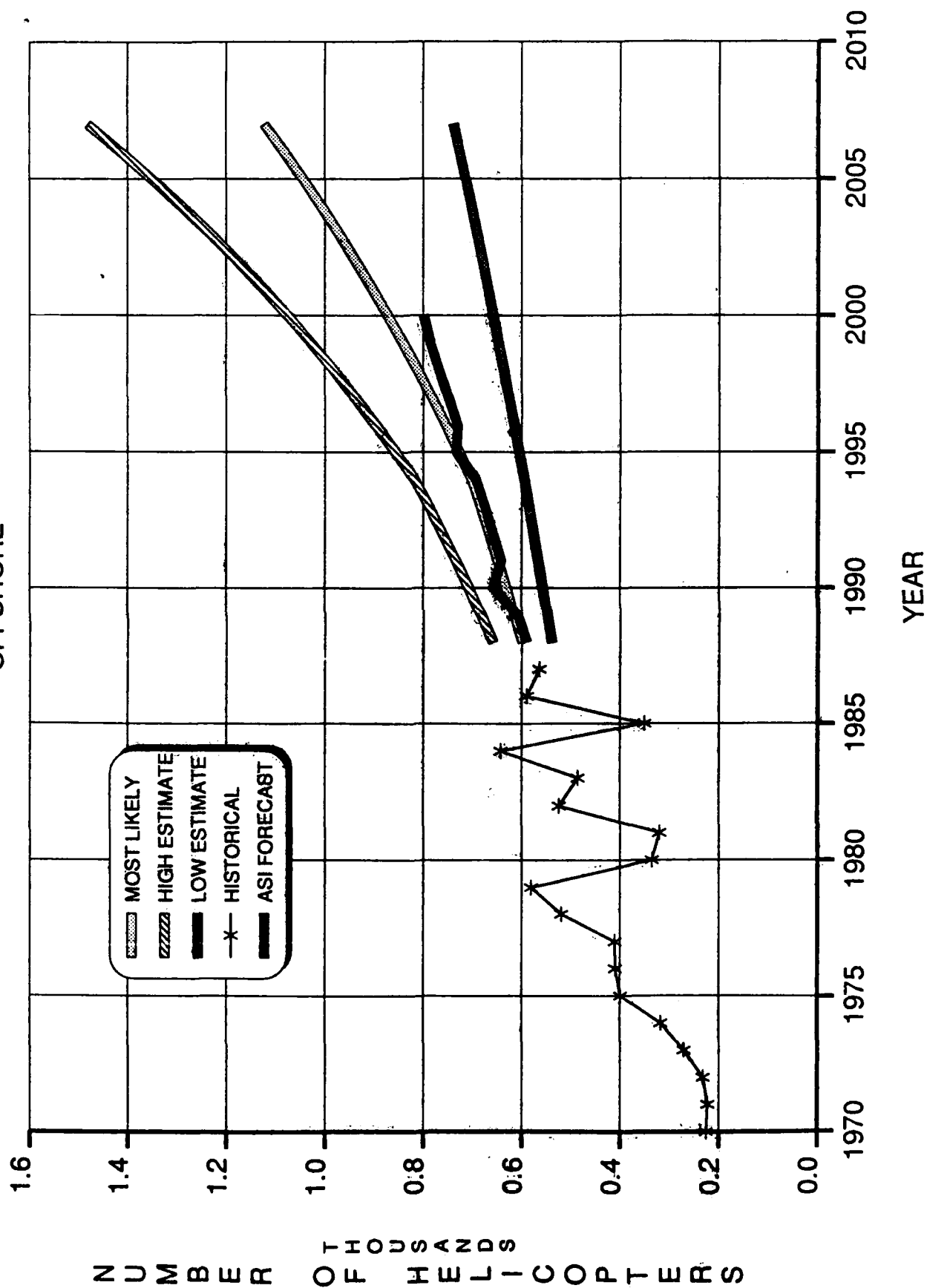
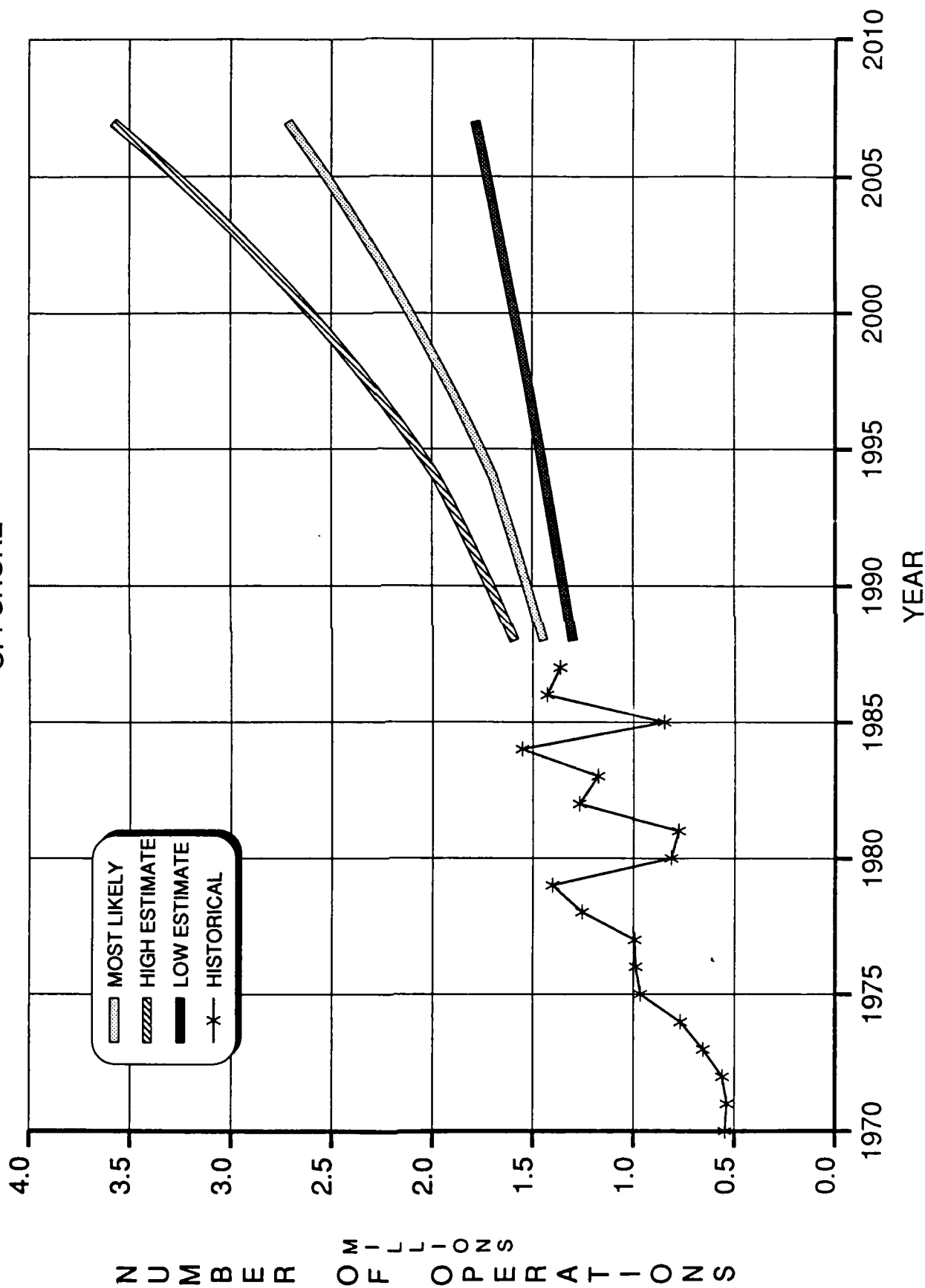


Figure 51

# OPERATIONS FORECASTS

OFFSHORE



Based on work performed for NASA Ames in 1980 and presented in an unpublished report entitled Investigation of Helicopters in Public Service: Requirements and Contributions, by R.J. Adams and L.D. King of Systems Control Technology, search and rescue mission flight hours range from 1 percent to 20 percent of the law enforcement flight hours. The lower numbers represent the experience of urban law enforcement agencies while the higher numbers represent the experience of agencies with rural and remote areas in their jurisdiction. Based on this analysis, the search and rescue flight hours were assumed to be 10 percent of the law enforcement flight hours.

#### 6.4.5.1 Search and Rescue Flight Hours

The basis for the aerial observation flight hours was established in Table 49. This value was adjusted by one standard error value to obtain high and low estimates of aerial observation flight hours. The search and rescue flight hours were determined by using the multipliers developed in Section 6.4.5.

$$\begin{aligned} \text{Search and rescue flight hours} &= \text{Aerial Observation Flight Hours} * \\ 64.0\% * 10.0\% \end{aligned}$$

Where 64.0% = Law Enforcement Flight Hours/Aerial Observation Flight Hours  
10.0% = search and rescue flight hours/law enforcement flight hours

The search and rescue flight hours for 1987 are then:

Most likely flight hour estimate	= 24,524 hours
High estimate	= 27,575 hours
Low estimate	= 21,473 hours

The growth rate for law enforcement/search and rescue missions was assumed to be one point greater than the growth rate for the total helicopter flight hours. The resulting growth rates are:

Most likely flight hour growth rate	= 3.7 percent per year
High estimate	= 5.1 percent per year
Low estimate	= 2.3 percent per year

The resulting search and rescue flight hour estimates are shown in Figure 52.

#### 6.4.5.2 Search and Rescue Fleet Size

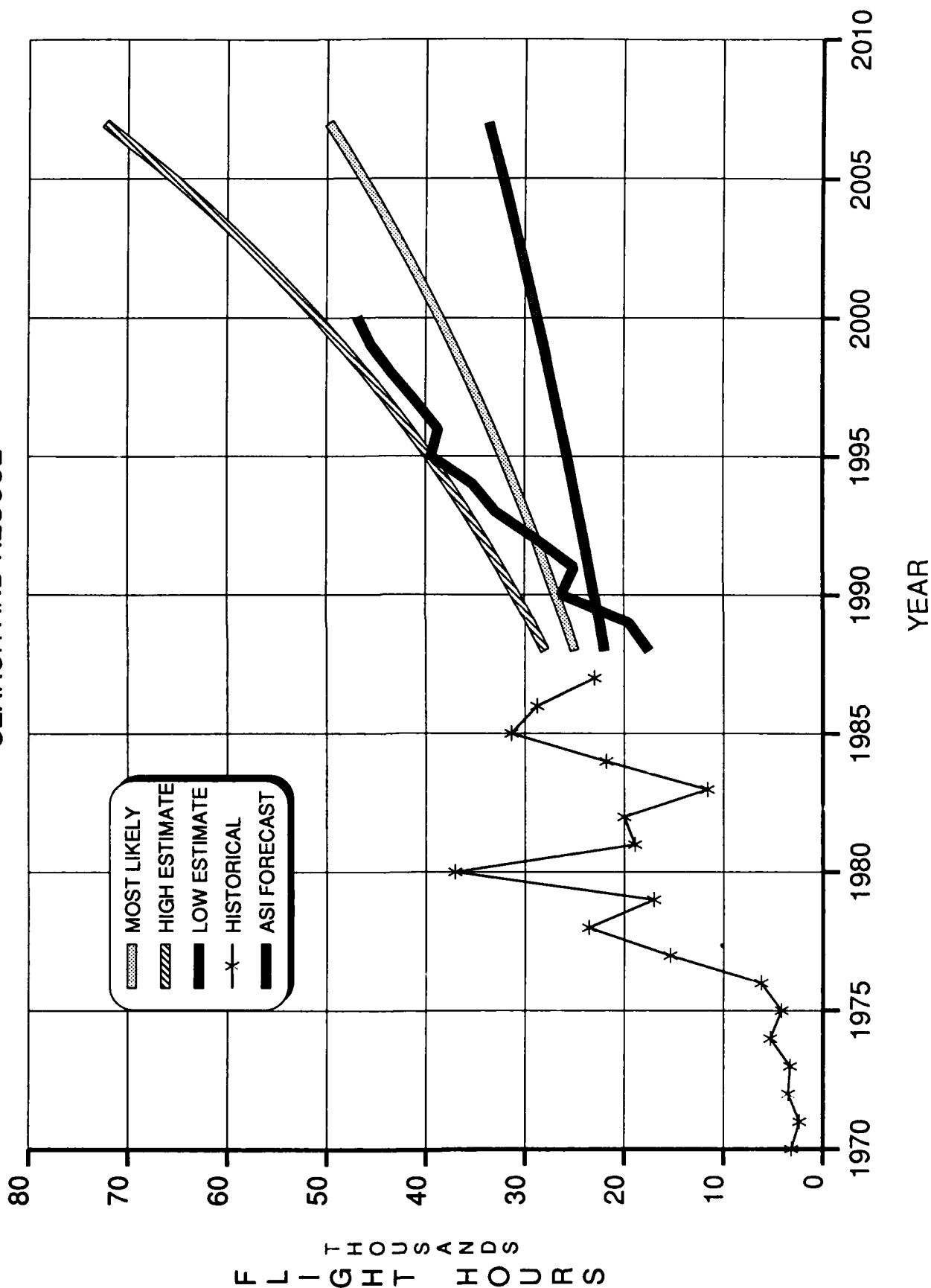
The basis for the aerial observation fleet was established from Table 48. This value was adjusted by one standard error value to obtain high and low estimates of the aerial observation fleet size. The search and rescue fleet was assumed to be equivalent to the law enforcement fleet size which was established in Section 6.4.5 as 54.4 percent of the aerial observation fleet size. The resulting search and rescue fleet size for 1987 was then:

Most likely search and rescue fleet size	= 497 helicopters
High estimate	= 536 helicopters
Low estimate	= 458 helicopters

# FLIGHT HOUR FORECASTS

Figure 52

SEARCH AND RESCUE



The growth rate for the law enforcement/search and rescue fleet was assumed to be one point greater than the growth rate for the total helicopter fleet. The search and rescue fleet growth rates are:

Most likely search and rescue fleet growth rate	= 3.7 percent per year
High estimate	= 4.7 percent per year
Low estimate	= 2.7 percent per year

The resulting forecasts of the search and rescue fleet are shown in Figure 53.

#### 6.4.5.3 Search and Rescue Operations

Search and rescue operations were determined from the search and rescue fleet size, Figure 53, and the estimated annual operations per helicopter from Table 52, and the fraction of missions that are search and rescue related. For helicopters in the Work primary use category, the annual operations factor is 1,339 operations per helicopter per year. Therefore, 10 percent of this figure or 134 operations per year was used to calculate search and rescue helicopter operations.

The resulting search and rescue operations estimates are shown in Figure 54.

#### 6.2.5.4 Search and Rescue Operating Area

Search and rescue operations can be expected to occur at any location. Traditionally such activity has occurred offshore and in remote areas. These areas will likely continue to show the greatest amount of activity.

#### 6.4.6 Business

##### 6.4.6.1 Business Flight Hours

The basis for the business flight hours was established from Table 49. This value was adjusted by one standard error value to obtain high and low estimates of business flight hours. The results are:

Most likely flight hour estimates	= 84,092 hours
High estimate	= 94,485 hours
Low estimate	= 73,699 hours

The growth rate for business flight hours is assumed to follow the growth rate pattern of the overall helicopter fleet as presented in Section 6.2.2.5. These rates are:

Most likely flight hour rate	= 2.7 percent per year
High estimate	= 4.1 percent per year
Low estimate	= 1.3 percent per year

Figure 55 presents the flight hour forecast, historical FAA survey data, and the ASI forecast for business helicopters.

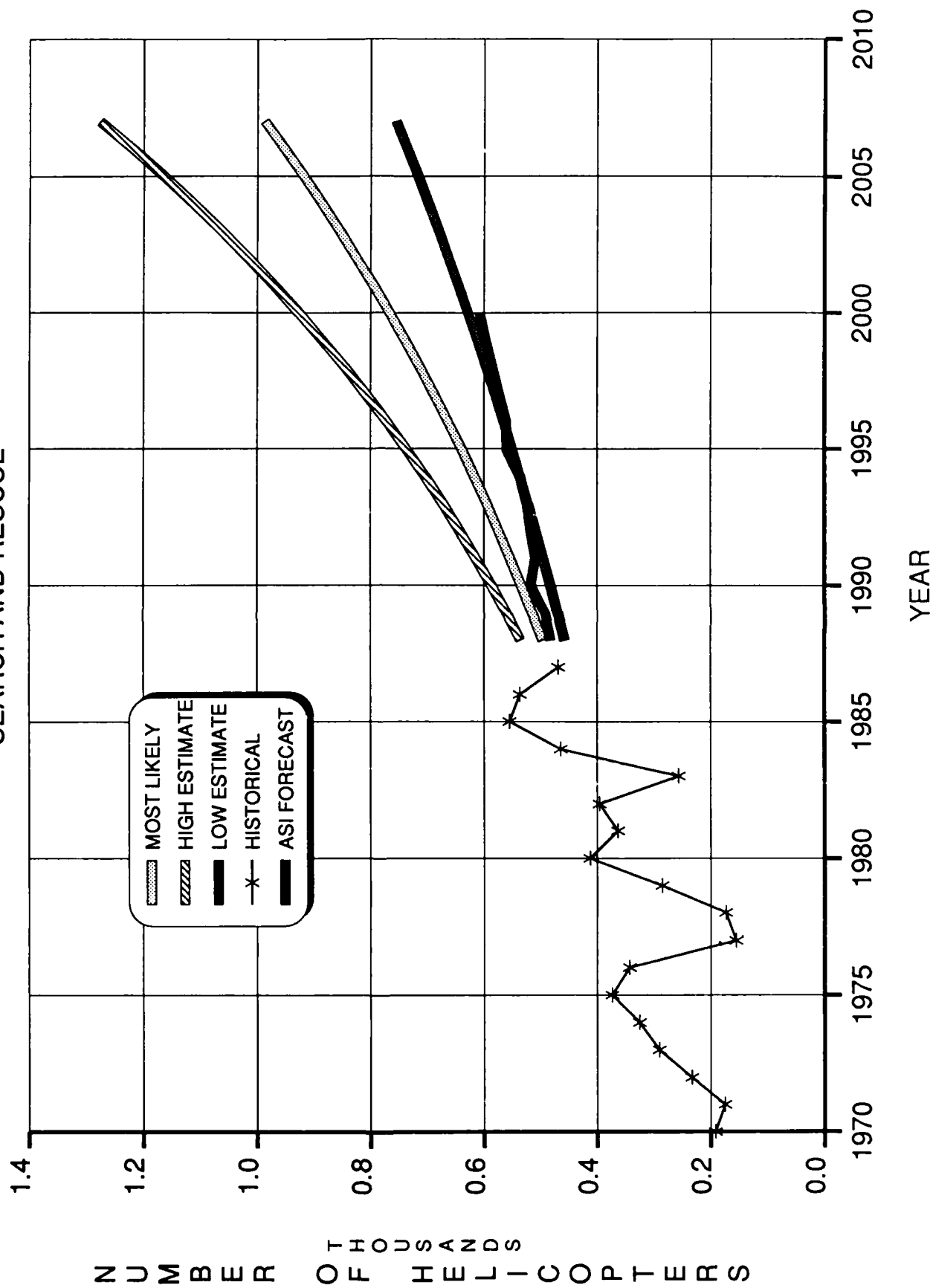
##### 6.4.6.2 Business Fleet Size

The basis for the business fleet size was established from Table 48. This value was adjusted by one standard error value to obtain high and

Figure 53

# FLEET FORECASTS

SEARCH AND RESCUE



# OPERATIONS FORECASTS

SEARCH AND RESCUE

Figure 54

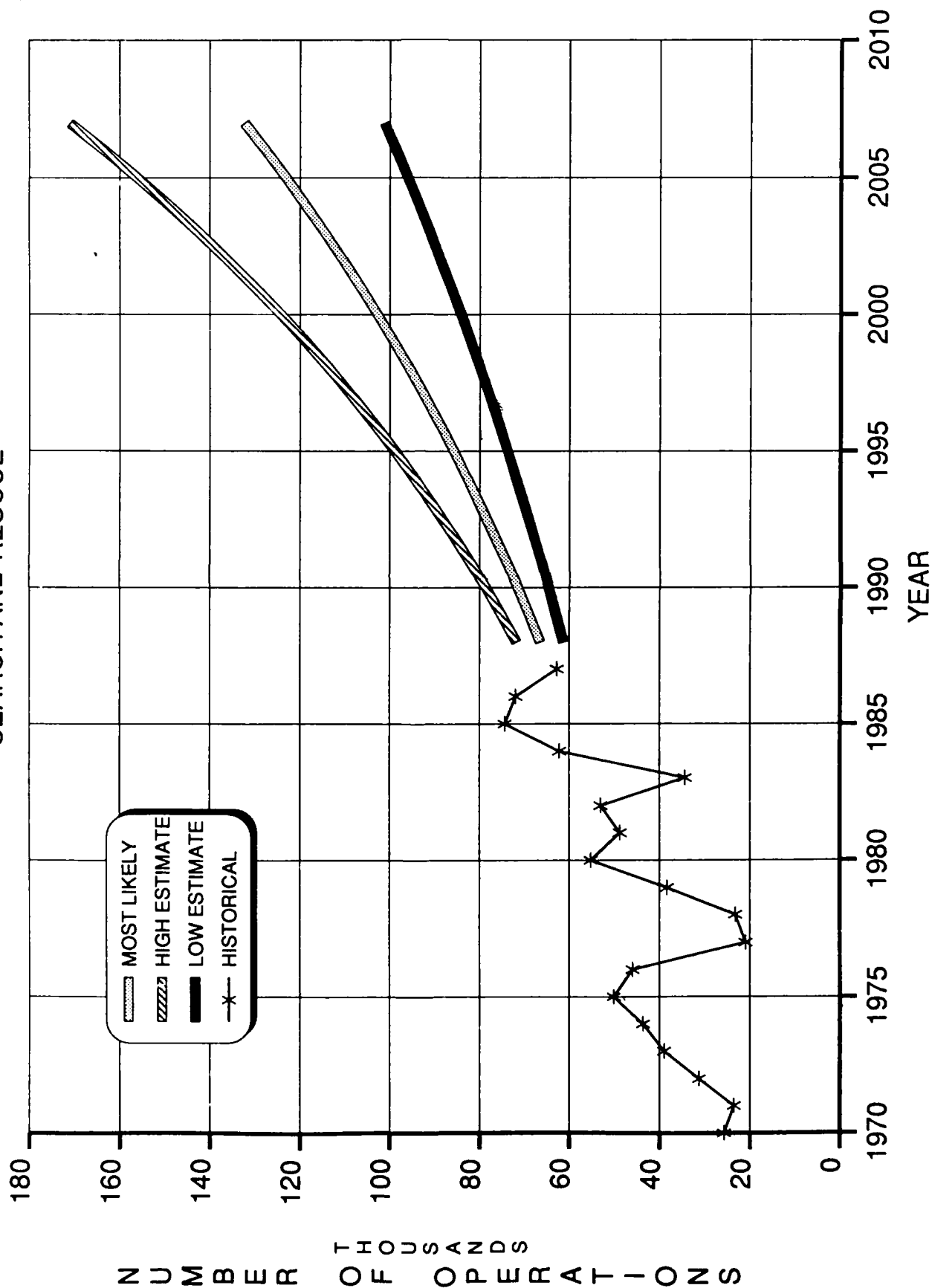
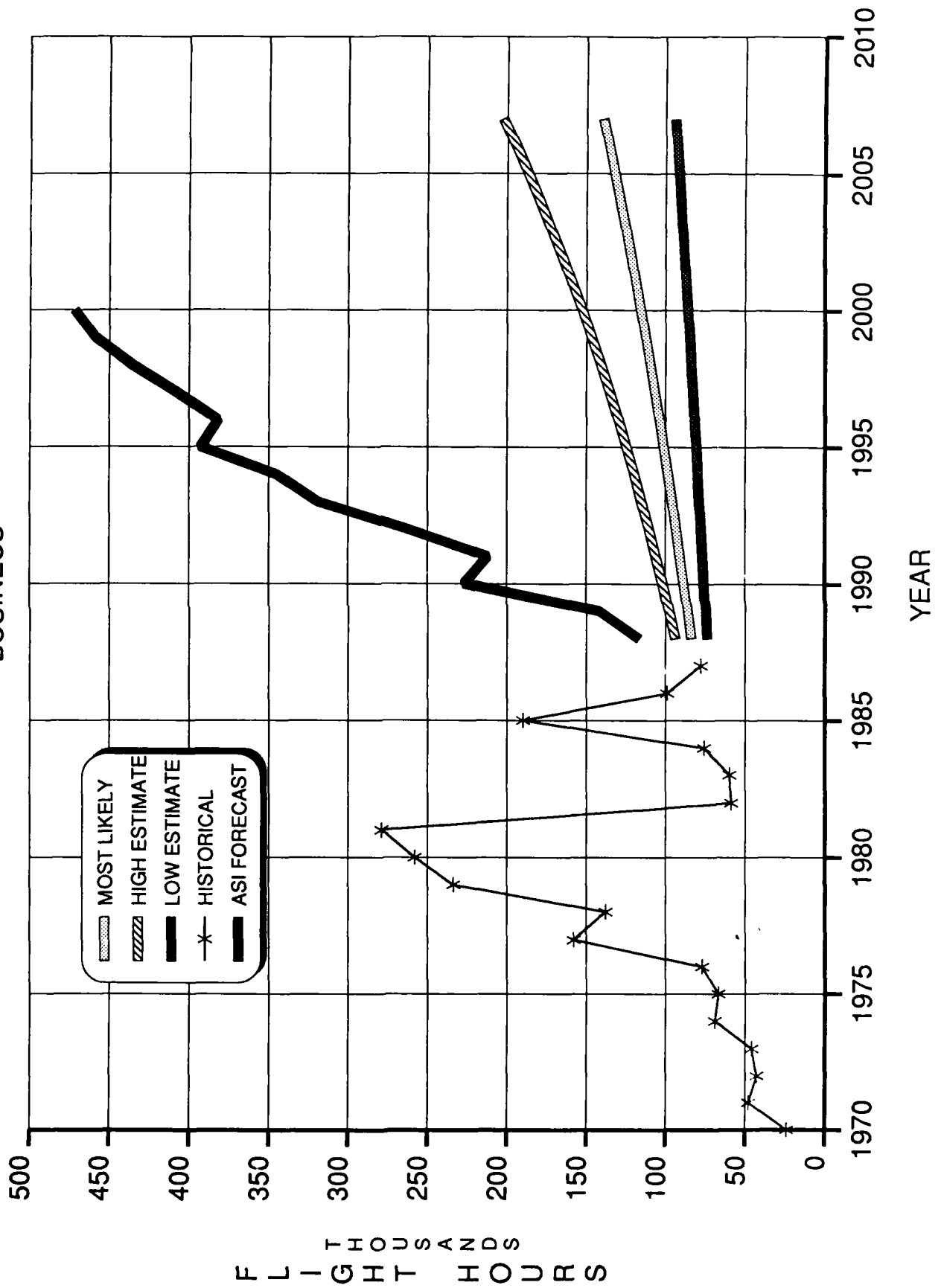


Figure 55

# FLIGHT HOUR FORECASTS

BUSINESS



low estimates of the business fleet size. The results are:

Most likely fleet size estimate	= 592 helicopters
High estimate	= 667 helicopters
Low estimate	= 517 helicopters

The growth rate for the business fleet size is assumed to follow the growth rate pattern of the total helicopter fleet as presented in Section 6.2.2.5. These rates are:

Most likely fleet size rate	= 2.7 percent per year
High estimate	= 3.7 percent per year
Low estimate	= 1.7 percent per year

Figure 56 presents the fleet size forecast, historical FAA survey data, and the ASI forecast for business helicopters.

#### 6.4.6.3 Business Operations

Business operations are determined from the business fleet size, Figure 56, and the estimated annual operations per helicopter from Table 52. For business helicopters this factor is 950 operations per helicopter per year. The estimated annual operations are shown in Figure 57.

#### 6.4.6.4 Business Operating Areas

Business operations are expected to continue to expand with the majority of the activity in the northeastern United States, southern California, and Florida and in metropolitan areas throughout the country.

#### 6.4.7. Air Taxi/Commercial

Air taxi/commercial data developed in this section refers to all air taxi and charter activity other than that directly involved in offshore oil support in the Gulf of Mexico, emergency medical service, and corporate executive missions.

##### 6.4.7.1 Air Taxi/Commercial Flight Hours

The basis for the air taxi/commercial flight hours was taken from the air taxi flight hour data in Table 49 and the offshore flight hour data in Section 6.4.4.1. This value was adjusted by one standard error value, assumed to be 10 percent, to obtain high and low estimates air taxi/commercial flight hours. The results are:

Most likely flight hour estimate	= 404,811 hours
High estimate	= 445,292 hours
Low estimate	= 364,330 hours

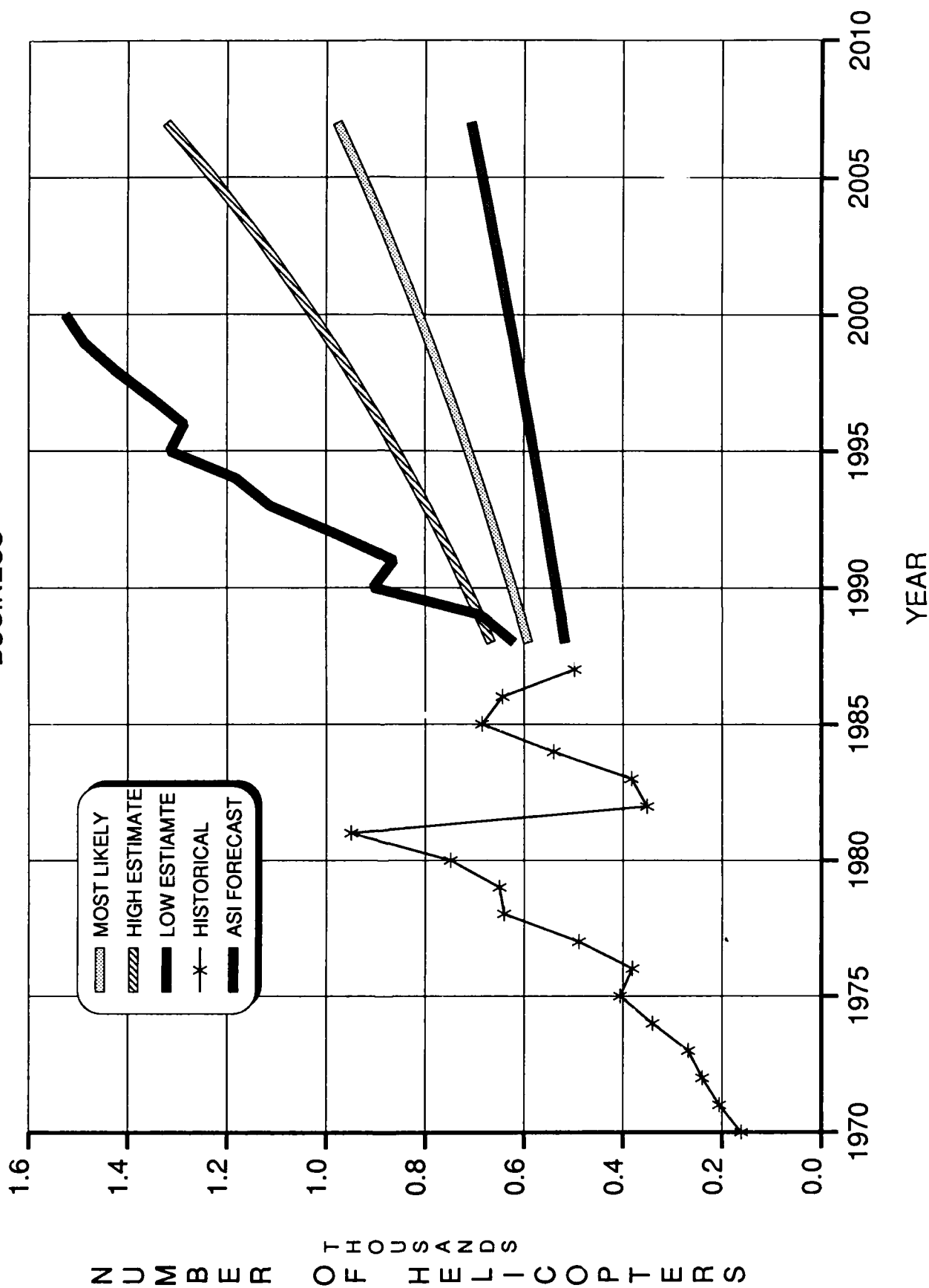
The growth rate pattern for air taxi/commercial flight hours was assumed to follow the growth rate pattern of the overall helicopter flight hours presented in Section 6.2.2.5. These rates are:

Most likely flight hour rate	= 2.7 percent per year
High estimate	= 4.1 percent per year
Low estimate	= 1.3 percent per year

Figure 56

# FLEET FORECASTS

BUSINESS



# OPERATIONS FORECASTS

Figure 57

BUSINESS

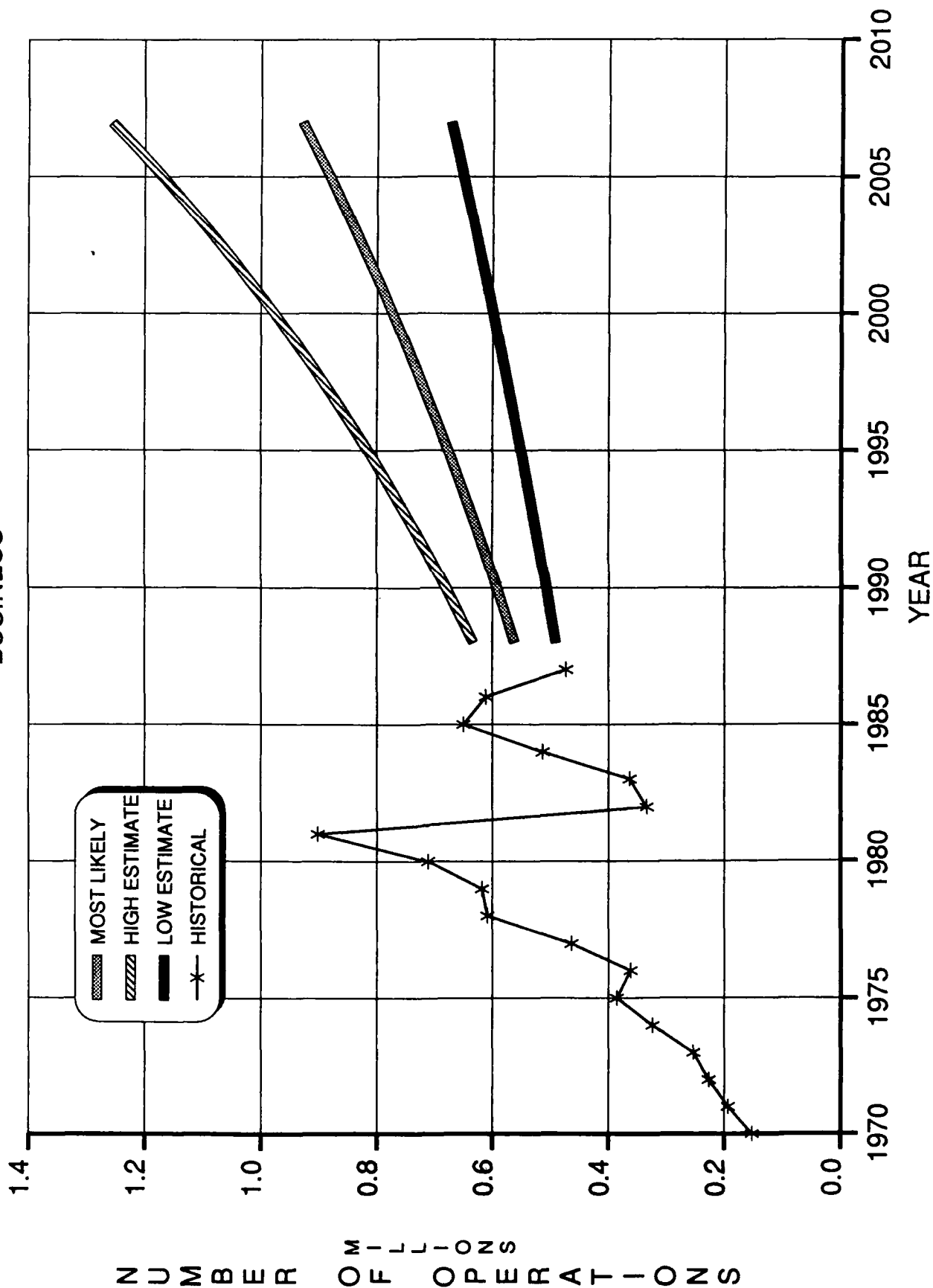


Figure 58 presents the flight hour forecast, historical FAA survey data, and the derived ASI forecast for air taxi/commercial helicopters.

#### 6.4.7.2 Air Taxi/Commercial Fleet Size

The basis for the air taxi/commercial fleet size was established from Table 48 and from Section 6.4.4.2. This value was adjusted by one standard error, assumed to be 10 percent, to obtain high and low estimates of the air taxi/commercial fleet size. The results are:

Most likely fleet size estimate	= 802 helicopters
High estimate	= 882 helicopters
Low estimate	= 772 helicopters

The growth rate for the air taxi/commercial fleet size is assumed to follow the growth rate pattern of the total helicopter fleet as presented in Section 6.2.2.5. These rates are:

Most likely fleet size rate	= 2.7 percent per year
High estimate	= 3.7 percent per year
Low estimate	= 1.7 percent per year

Figure 59 presents the fleet size forecast, historical FAA survey data, and the derived ASI forecast for air taxi/commercial helicopters.

#### 6.4.7.3 Air Taxi/Commercial Operations

Air taxi/commercial operations are determined from the air taxi/commercial fleet size, Figure 59, and the estimated annual operations per helicopter from Table 52. For air taxi helicopters this factor is 2,419 operations per helicopter per year. The estimated annual operations are shown in Figure 60.

#### 6.4.7.4 Air Taxi/Commercial Operating Areas

Air taxi/commercial operations are expected to continue throughout the United States with the majority of the activity in the northeastern United States, northwestern United States, southern California, and Florida.

### 6.5 ERROR SOURCES AND EFFECTS

As evidenced in the preceding sections, historic and forecast helicopter information have widely ranging degrees of accuracy. This is due to two basic uncertainties; first, in the number of active helicopters and second in the use of those helicopters in terms of types of missions flown, hours flown in those missions, and number of operations in those missions. These uncertainties are compounded by the relatively high purchase price and the inherent flexibility of the helicopter to perform many operations.

The number of active helicopters is bounded on the upper side by the total number of registered helicopters. Those registrations are updated on a three-year cycle and many unserviceable helicopters are not removed from the official records in a timely manner. Due to the relatively high purchase price of many helicopters, registered helicopter owners are

# FLIGHT HOUR FORECASTS

Figure 58

AIR TAXI/COMMERCIAL

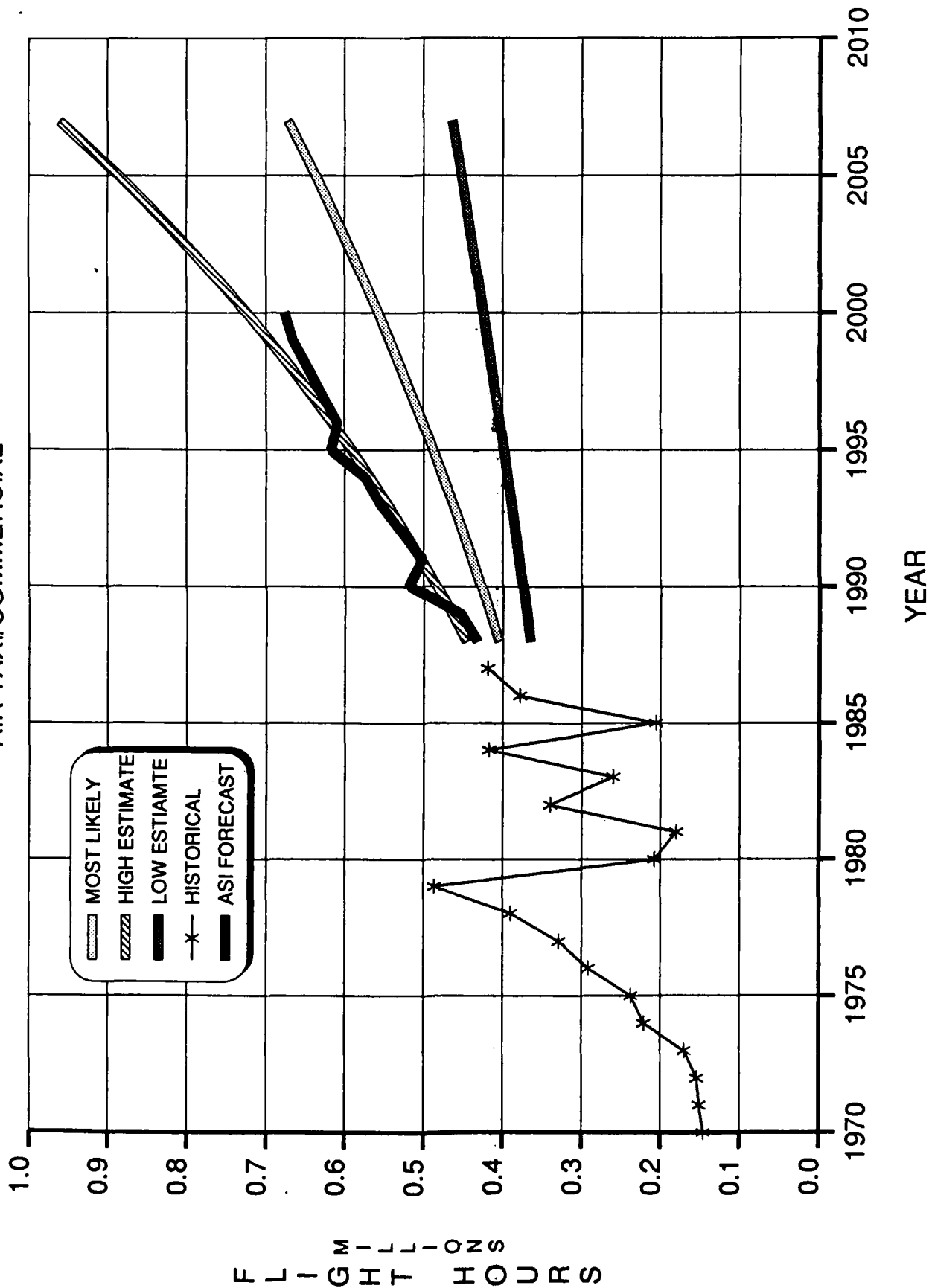
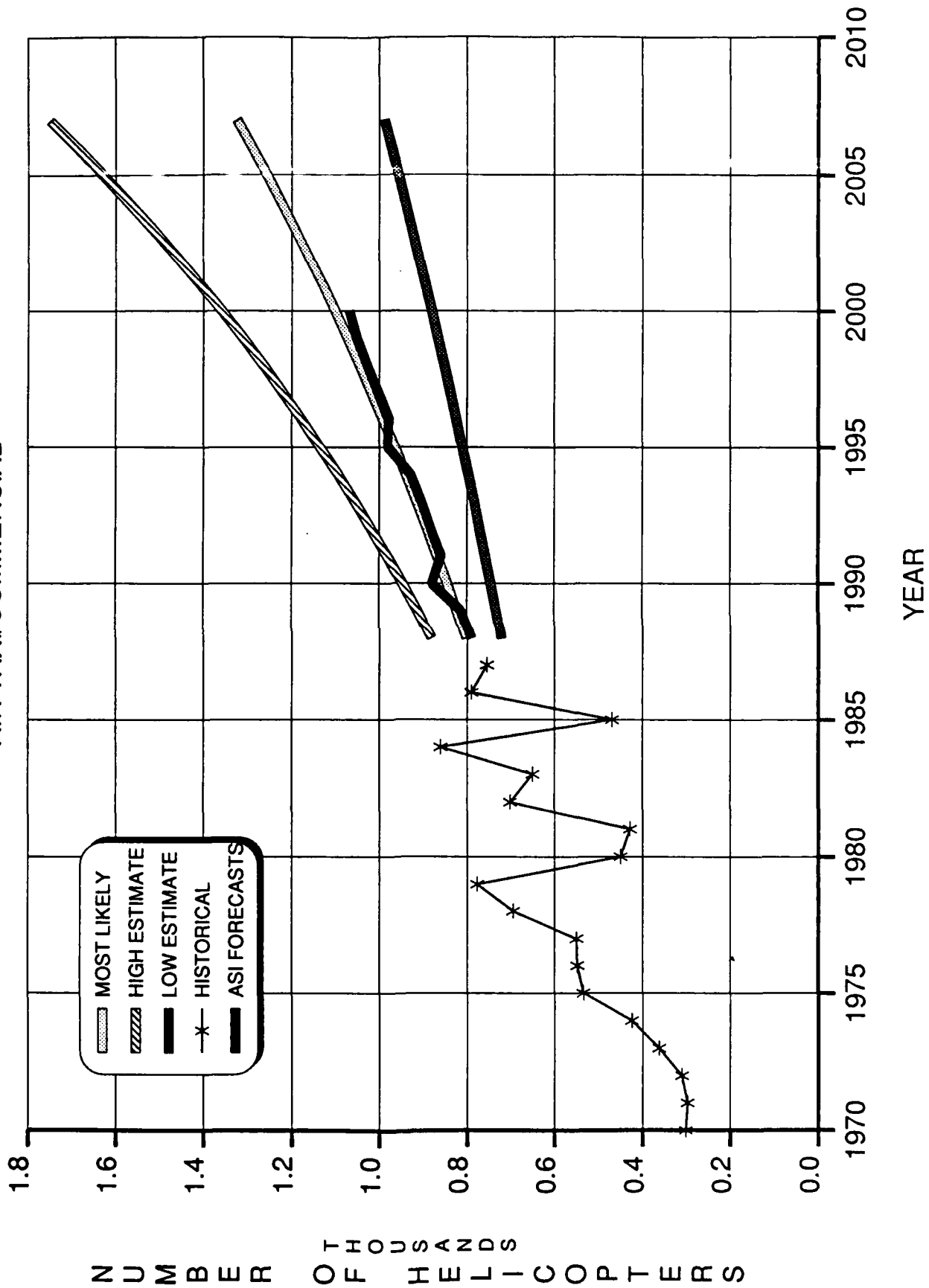


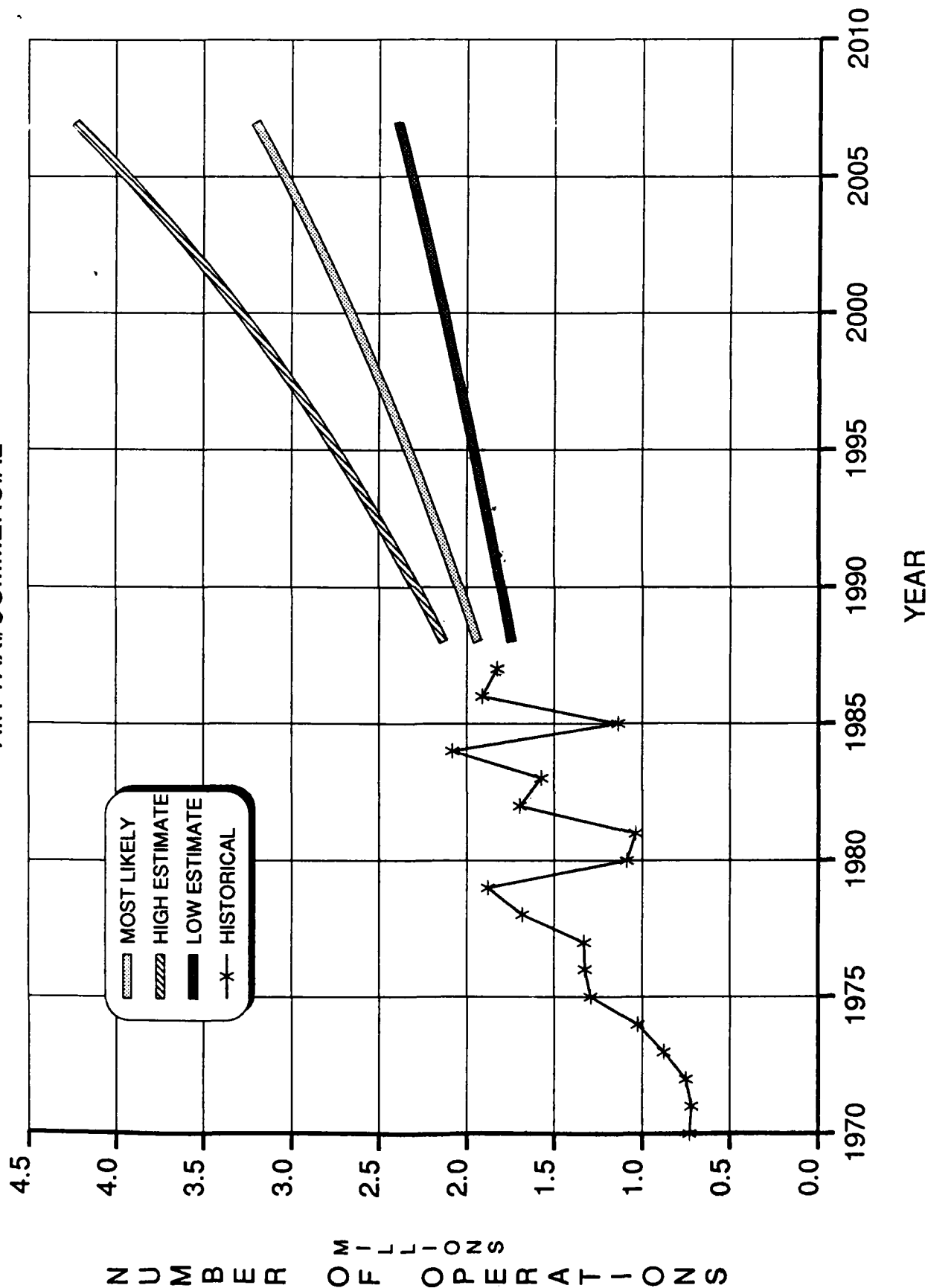
Figure 59  
**FLEET FORECASTS**  
 AIR TAXI/COMMERCIAL



# OPERATIONS FORECASTS

Figure 60

AIR TAXI/COMMERCIAL



often a bank or holding company which leases the aircraft to an operator, often in another location. Registered owners may not have any operational information on how a particular helicopter is used or even if it is airworthy. They also may perceive no benefit from responding to survey questionnaires such as the FAA general aviation survey or the one-time HFI survey.

Reduced response rates to surveys in turn reduce the size of the population which must then somehow be expanded to estimate the total active population. This may cause swings in flight hour or use trends depending on the response rate of each mission.

As shown in Table 7, some helicopter models (usually light utility) tend to be flown in multiple missions while others (usually heavy turbine) are used strictly for one task. The current FAA method of assigning a single primary use per helicopter survey response may mask these trends and result in under estimation of flight hours, active helicopters, and operations in some missions.

Changing economic climates or other factors may result in excess helicopter capacity in certain geographic areas or mission types. The helicopter operators may choose to circumvent this problem by moving the helicopters to another area, using them for another mission, flying fewer hours or operations, storing or selling helicopters, or operating in foreign countries. If these helicopters had previously been counted in one mission area, the secondary use would go unreported.

There are no easy solutions to these problems but some suggestions can be made to reduce the effect of several of them.

1. Attempt to correlate helicopter operators with helicopter owners and then survey only the operators.
2. Expand the categories of use to include as many mutually exclusive missions as possible.
3. Provide clear guidelines to operators on how to record their data particularly in distinguishing "business" from "corporate/executive," and "offshore" for "air taxi."
4. Retain as much detail on distinct missions as possible with combination only for comparison to historic data.
5. Allow addition of new missions as they emerge and grow such as EMS has during the last decade.

## ANNOTATED BIBLIOGRAPHY AND SOURCES

### Documents

1. Census of U.S. Civil Aircraft - Calendar Year 1986, U.S. Department of Transportation, Federal Aviation Administration.

A report published by the FAA presenting statistics on the U.S. civil aircraft fleet. The data includes detailed tables of air carrier aircraft, an inventory of registered aircraft by manufacturer and model, and general aviation aircraft by state and county of the owner.

2. FAA Statistical Handbook of Aviation, Calendar Year 1985 and 1986, U.S. Department of Transportation, Federal Aviation Administration.

A report published by the FAA that presents information pertaining to the FAA, the National Airspace System, airports, airport activity, U.S. civil air carrier fleet, U.S. civil air carrier operating data, airmen, general aviation aircraft, aircraft accidents, aeronautical production and imports/exports, and a glossary of the terms used.

3. FAA Aviation Forecasts - Fiscal Years 1988-1999, U.S. Department of Transportation, Federal Aviation Administration.

This document presents the FAA forecasts of aviation activity at FAA facilities, including airports with FAA control towers, air route traffic control centers, and flight service stations. The activity of the four major users of the National Airspace System were forecasted, including air carriers, air taxi/commuters, general aviation and military. The purpose of this document is to provide data for the planning and budget needs of the above mentioned facilities.

4. General Aviation Activity and Avionics Survey: Annual Summary Report 1986 Data, U.S. Department of Transportation, Federal Aviation Administration, FAA-MS-87-5.

This document presents the results and a description of the 1986 General Aviation Activity and Avionics Survey. It surveys registered general aviation aircraft based on a statistically selected sample of about 10.5 percent of the GA fleet. For this document a 54.6 percent response rate was achieved. The numbers are expanded to assume figures for the entire population of general aviation aircraft.

5. Aerospace Facts and Figures 1984/85, Aerospace Industries Association (AIA), Washington, D.C.

The AIA publishes a yearly document that presents statistics on the aviation industry in the United States. These documents are published for fiscal years. Each issue has a section that presents the current numbers of helicopters and heliports based on various sources.

6. Aerospace Facts and Figures 1985/86, Aerospace Industries Association (AIA), Washington, D.C.

The AIA publishes a yearly document that presents statistics on the aviation industry in the United States. These documents are published for fiscal years. Each issue has a section that presents the current numbers of helicopters and heliports based on various sources.

7. Aerospace Facts and Figures 1986/87, Aerospace Industries Association (AIA), Washington, D.C.

The AIA publishes a yearly document that presents statistics on the aviation industry in the United States. These documents are published for fiscal years. Each issue has a section that presents the current numbers of helicopters and heliports based on various sources.

8. Aerospace Facts and Figures 1987/88, Aerospace Industries Association (AIA), Washington, D.C.

The AIA publishes a yearly document that presents statistics on the aviation industry in the United States. These documents are published for fiscal years. Each issue has a section that presents the current numbers of helicopters and heliports based on various sources.

9. "Third Helipad Survey," Hospital Aviation, Volume 6, Number 5 - May 1987.

This article presents the results of the third hospital helipad survey. It reported very few differences from the second hospital helipad survey. The magazine mailed out 130 surveys with 91 responding.

10. "Mid-Year Report," Collett, Howard M., Hospital Aviation, Volume 6, Number 7 - July 1987.

The EMS program summary was presented in the editorial section of this issue. It provides the mid-1987 status of industry with an emphasis on the helicopters used in EMS.

11. "Civil U.S. Aeromedical Programs (Hospital-Based Helicopters)," Hospital Aviation, Volume 6, Number 10 - Oct 1987.

This is a list of all hospital-based EMS programs in the United States as of October 1987. It is presented by state.

12. "1987 Most Eventful Year Ever!, Year-End Report," Collett, Howard M., Hospital Aviation, Volume 7, Number 2 - Feb 1988.

This article presents the yearend report of the status of the EMS industry as of December 1987. It provides data on the growth of EMS programs and discusses various issues such as safety, excise tax, and the pilot shortage.

13. "Aeromedical Accident Trends," Collett, Howard M., Hospital Aviation, Volume 7, Number 2 - Feb 1988.

This article discusses the aeromedical accident trends for fatal, injury and damage accidents. It further discusses the causes of accidents including pilot error and mechanical failure. Tables and graphs are provided.

14. "Annual Transport Statistics," Hospital Aviation, Volume 7, Number 3 - Mar 1988.

This article presents a discussion supported by tables of the numbers of annual patient transported in 1987. It presents the data by the type of transport, i.e., scene, sponsor, night, one-way miles, etc. It further compares these statistics to prior year data.

15. "The Ides of March", Collett, Howard M., Hospital Aviation, Volume 7, Number 3 - Mar 1988.

This is an editorial on what he calls the "re-regulation" of the EMS industry, inspired by the new FAA requirements on pilot flight and duty time.

16. "Directory of Air Medical Services, Air Medical Services Directory," Hospital Aviation, Volume 7, Number 4 - Apr 1988.

This article is the current list of EMS programs presented by state. It also provides data on the types of aircraft (rotor-wing vs. fixed-wing) and provides addresses, phone numbers, and management data.

17. "The Cost of Air Medical Helicopter Programs," Collett, Howard M., Hospital Aviation, Volume 7, Number 5 - May 1988.

This article compares the costs of operating an EMS program for the years 1983 and 1988. It also discusses the implications of the costs and future of the EMS programs.

18. "First Helicopter Operator Survey," Hospital Aviation, Volume 7, Number 5 - May 1988.

This is a discussion of the first EMS helicopter operator survey. It presents data on pilot/mechanic requirements, flight schools and training, pilot rating, and other pertinent operator policies.

19. "IFR Scene Flight", Steinbrunn, Robert N., Hospital Aviation, Volume 7, Number 6 - June 1988.

This article was written by an EMS pilot who routinely flies IFR in the performance of his duty. He discusses the advantages and disadvantages of flying IFR.

20. "1988 Transport Charge Survey," Collett, Howard M., Hospital Aviation, Volume 7, Number 6 - June 1988.

This article presents EMS 1988 transport costs by the six areas identified by Hospital Aviation. It provides a summary by area of the average cost and percent of increase experience in the past few years. This includes the costs of twin vs. single engine helicopters and a history of the costs for leased helicopters.

21. "Air Medical Helicopter Transport, Mid-Year Report," Hospital Aviation, Volume 7, Number 7 - July 1988.

The EMS program summary was presented in the editorial of this issue. It provides the mid-1988 status of industry with an emphasis on the helicopters used in EMS.

22. "Outcome Evaluation of Trauma Patients Transported By a Rural Hospital-Based Helicopter EMS Program," Boyd, Carl R., MD, and Corse, Kathleen M., BSN, Hospital Aviation, Volume 7, Number 7 - July 1988.

An article discussing the outcome of a study completed to document the benefits of helicopter EMS transfer compared to ground ambulance transfer.

23. "1986 Annual Aeromedical Aircrew Survey," Collett, Howard M., Hospital Aviation, Volume 6, Number 8, August 1987.

An extensive survey of EMS programs was completed by Howard Collett of Hospital Aviation to obtain more detailed data on EMS programs. The data include type of helicopters, type of avionics, numbers of transport requests, reasons for not completing requests, destinations of individual operators, weather minimums, and crew staffing.

24. HFI, STATS Program

A one-time survey was conducted in 1988 by the Helicopter Foundation International. HFI surveyed the entire registered civilian helicopter fleet to obtain a database independent of the General Aviation Survey. Helicopter owners were identified from the Rotor Roster.

25. "Part 91 Operators, Quest for Frustration-Free Flight," Rotor and Wing Rotorcraft Report, Volume 2, Number 15, July 1988.

This article presented a profile of the survey results of the Rotor and Wing's Part 91 operators survey. It discussed operator characteristics as well as the problems most corporate/executive operators felt were hindering their operations.

26. Helicopter Annual - HAI 1988 and 1989.

The Helicopter Association International publishes the Helicopter Annual issued at its annual meeting. This document presents various facts about the helicopter industry including numbers of helicopters and primary use. The data comes from its members, which does not include all helicopters or operators.

27. "NTSB Views Weather and EMS Safety", Negrette, Arthur J., Safety Column, Rotor and Wing International, Volume 22, Number 5, May 1988.

This article discusses the problems of weather with regard to EMS helicopter accidents. It includes the fact that poor weather poses the greatest single hazard to EMS operations as well as some of the reasons why.

28. "Iowa's First and Biggest In EMS: Air Care", Edgington, Bryon H., Rotor and Wing International, Volume 22, Number 5, May 1988.

An article discussing the various aspects of one EMS operator in Iowa including safety, equipment, crew qualifications, and provides stories of specific patient transports.

29. "The Dual Roles of Doppler Radar," Underwood, David, Rotor and Wing International, Volume 22, Number 6, June 1988.

This article discusses the advantages and disadvantages of doppler radar for navigation.

30. "Into the '90s: An Energy of Hope", McLean, Herbert E., Rotor and Wing International, Volume 22, Number 6, July 1988.

This article discusses the current status of the helicopter industry and the projected future by mission from the economic trend point of view and from the operators'. It includes a history of free world civil turbine helicopter deliveries, the U.S. piston market, and economic trends in associated industries.

31. "EMS Helicopters - An Annual Report," Spray, Russ, Vertiflite, Volume 34, Number 1, January/February 1988.

Russ Spray, Vice President of Rocky Mountain Helicopters, presents a discussion with graphics on the current status of the EMS helicopter industry.

32. "How Many Civil Helicopters Are There?," Zugschwert, John F., Vertiflite, Volume 34, Number 1, January/February 1988.

John Zugschwert, of the American Helicopter Society (AHS), discusses how the different sources of helicopter statistics conflict.

33. "Helicopters on Long Island: Something for Everyone," Preston, Noel G., Vertiflite, Volume 34, Number 4, July/August 1988.

This article discusses the missions and operating characteristics of the helicopter operators on Long Island, New York. These operators include; New York City Police Department Aviation Unit, United States Coast Guard, Island Helicopter Corporation, New York Helicopter Corporation, the Nassau County Police Department Air Bureau, Thompson Industries, Suffolk County Police Department Aviation System, and Grumman Corporation.

34. "Better Times for the Offshore Depend on Oil Prices," Offshore Yearbook, International Journal of Ocean Business, - 1987 Edition.

This editorial discusses the offshore business changes within the previous 18 months. The main point is that even though there is still a depression in the Gulf, there are indications that it will get better soon.

35. "Oilmen to Face Uncertain Years Ahead," Offshore Yearbook, International Journal of Ocean Business, - 1987 Edition.

This article discusses how the uncertainties of the oil price and world consumption will determine the petroleum market of the next three years.

36. "Hike in Drilling Possible for 1987," Offshore Yearbook, International Journal of Ocean Business, - 1987 Edition.

This article states that if OPEC can restrict its production to keep the price of oil between \$15 - \$20 per bbl. the levels of exploration will increase.

37. "Helicopter Sale Forecasts," ICAO Committee on Aviation Environmental Protection (CAEP), Working Group II, Meeting April 27-29, 1988, Boston Massachusetts, U.S.A.

Using figures developed by the Transportation Research Board (TRB) this paper states that the small growth of the world-wide military helicopter market does not offset the decline in the civil market. It predicts slow growth over the next 10 years of an average of 3.8 percent per year for both civil and military helicopters.

38. "The Future of Aviation," Transportation Research Circular, Fifth International Workshop, National Academy of Sciences October 6-8, 1987, Washington, D.C., Transportation Research Board/National Research Council.

39. Commercial Emergency Medical Service Helicopter Operations, Safety Study, National Transportation Safety Board, Washington, D.C., NTSB/SS-/01, January 28, 1988.

40. "Status of the Offshore Oil Industry as of 7/1/88, Statistical Review of Events Between 1/1/88-7/1/88," Offshore Oil Scouts Association, Chalmette, LA, 1988.
- Offshore oil statistics including production and number of rigs.
41. "Gulf of Mexico Update: July 1986-April 1988," OCS Information Report, Minerals Management Service, 88-0038, Vienna, VA 1988.
- Offshore oil production and industry.
42. "Visual No. 1 - Historic Leasing and Infrastructure," Department of the Interior, Minerals Management Service, Gulf of Mexico, OCS Regional Office, March 1988.
- Map of western Gulf of Mexico offshore leasing areas.
43. "Visual No. 1E - Historic Leasing and Infrastructure," Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, September 1987.
- Map of eastern Gulf of Mexico offshore leasing areas.
44. Helicopter Forecasting Assessment, Final Report for Tasks II, III, and IV, Applied Systems Institute (ASI), prepared for Office of Aviation Policy and Plans, Federal Aviation Administration, March 30, 1989.
- This report prepared by ASI assesses the accuracy of rotorcraft statistical data in the General Aviation Activity and Avionics Survey by comparing to ASI's forecasts based on the HFI survey data.
45. Rotor Roster, 1988, Air Track, Hilliard, Florida.
- This is a database of helicopters registered with the FAA, published commercial use.
46. "MMS: In Perspective," U.S. Department of the Interior Minerals Management Service.
- Booklet published by the Department of Interior discussing location and production levels of offshore oil.
47. "What's New In General Surgery: Impact of Helicopters on Trauma Care and Clinical Results," Annals of Surgery, Vol. 208, Number 6, December 1988.
- Reviews the history of the development of civilian helicopter ambulance programs as a component of a total emergency medical services system. Discusses reduction in trauma mortality for those patients transported by air either from the scene or from another medical center.

48. "Annual Review of Aircraft Accident Data," National Transportation Safety Board, NTSB/ARG-8/01, U.S. General Aviation Calendar Year 1986.

This report presents a statistical compilation and review of general aviation accidents which occurred in 1986 in the United States, its territories and possessions, and in international waters. The accidents reported are all those involving U.S. registered aircraft not conducting operations under 14 CFR 121, 14 CFR 125, 14 CFR 127, or 14 CFR 135.

49. "Aeronautical Decision Making For Helicopter Pilots," developed for FAA by SCT in concert with AOPA, Ohio State University, Transport Canada. Adams, Richard, & Thompson, John, DOT/FAA/PM-86/45.

This training manual explains the risks associated with helicopter flying activities, the underlying behavioral causes of typical accidents, and the effects of stress on pilot decisionmaking. It provides self-assessment inventory and detailed pre-flight and in-flight stress management techniques.

50. "Review of Rotorcraft Accidents, 1977-1979," National Transportation Safety Board, Washington, D.C., 1981.

Discusses rotorcraft accidents by type of accident, the persons involved, fatalities, by year. It analyzes different accidents and presents the statistics in various formats.

51. A Heliport System Plan for Downstate New York, Technical Memorandum, Edwards and Kelcey, Boston, 1988. Selected sections.

A heliport system plan covering helicopter operations and heliports for downstate New York (includes New York City and the counties of Suffolk, Westchester, Ulster, Nassau, Rockland, Putnam, Dutchess, Orange and Sullivan) describing the number and missions of helicopters in the area. Selected sections.

52. Master Plan and Feasibility Study of a Boston Heliport System Plan, Edwards & Kelcey, Boston, 1988.

A heliport system plan covering helicopter operations and heliports for the city of Boston describing the number and missions of helicopters in the area. Selected sections.

53. New Jersey Helicopter System Plan, Edwards and Kelcey, Boston, 1985.

A heliport system plan covering helicopter operations and heliports for the state of New Jersey describing the number and missions of helicopters in the area. Selected sections.

54. Heliport System Plan for Philadelphia, Edwards and Kelcey, Boston, 1988.

A heliport system plan covering helicopter operations and heliports for the city of Philadelphia describing the number and missions of helicopters in the area. Selected sections.

55. "Service To the Company is the Goal," Grady, Julie C., Rotor, Fall 1988.

Article on Digital Equipment Corporation's in-house helicopter service.

56. "A Cost Benefit Analysis of Navigation, Communication and Surveillance Systems' Low Altitude Coverage Improvements", Vol. I & II, ARINC Research Corporation, July 1985. Unpublished.

A study to determine the potential viability of enhancing low altitude communication, navigation, and surveillance (CNS) system coverage, primarily in support of rotorcraft operations.

57. "Atlantic Summary/Index: January 1985-1986; Outer continental Shelf Oil & Gas Activities", Wiese, Jeffrey D., U.S. Department of the Interior Minerals Management Service OCS Information Program, MMS 86-0071, 1986.

Describes the geology, resource estimates, areas and level of oil and gas production.

58. "Alaska Update: January 1987-August 1988; Outer continental Shelf Oil & Gas Activities," U.S. Department of the Interior Minerals Management Service OCS Information Program, MMS 86-0071, 1986.

Describes the geology, resource estimates, areas and level of oil and gas production of Alaska.

59. Summary of Synoptic Meteorological Observations: North American Coastal Marine Areas- Revised Atlantic and Gulf Coasts, Naval Weather Service Command, AD-A008 889, May 1975.

Contains tables of historic weather and marine data including ceiling, visibility, cloud cover, etc., compiled from observations taken between 1857 and 1971.

60. U.S. Navy Climatic Study of the Caribbean Sea and the Gulf of Mexico Volumes 3 & 4. Naval Oceanographic Command Detachment, Asheville, NC, September 1986.

Contains charts, tables and maps of marine data compiled from 1.4 million surface observations taken between 1854 and 1983. This data includes ceiling, visibility, clouds, temperatures, and wave heights.

61. "Private Eye Peruses Sleuthing in the Sky," Rotor and Wing International, August 1986.

Describes the business aviation activities of a part 91 operator using an R-22 for varied duties.

62. "Corporate Ops Startups: Making the Decisions," Rotor and Wing International, January 1987.

Description of business and executive operations conducted by businesses under Part 91 and by leased helicopters from part 135 operators.

64. "Foggy Notions Dispelled for Fixed-Wing Favorers", Rotor and Wing International, March 1987.

Description of a business flight conducted by a S-76 and a DH-125 business jet from Washington, DC, to York, PA and return.

65. "Million Dollar Baby Nutures An FBO Network," Rotor and Wing International, March 1987.

Describes operations by Million Air, a leading Part 135 charter operator, describes advantages of combining helicopter with fixed wing aircraft for business and corporate use.

66. "How Corporate Flying Blossomed in Florida," Rotor and Wing International, October 1987.

Describes growth of business and corporate use of helicopters in south central Florida. Includes examples of corporate and business operations.

67. "One Corporate Helicopter Sortie with a Twist," Rotor and Wing International, December 1987.

Describes a Part 91 operation in New York City which also leases its helicopter to a Part 135 charter operator to decrease operating costs.

#### Telephone Interviews

1. Howard Collett, telephone interview.

Howard Collett is the publisher of Hospital Aviation magazine. For this study Mr. Collett was interview by telephone to determine his opinion of the current trends in the emergency medical services (EMS) industry.

2. Insurance Company Telephone Interviews.

- a. Marsh McLennan
- b. Aviation Office of America
- c. Southern Marine & Aviation
- d. Southeastern Aviation Underwriters
- e. Associated Aviation Underwriters

These insurance brokers are considered those that provide the most aviation insurance. None could or would release any data.

3. Helicopter Manufacturers Telephone Interviews.

Marketing departments and various other departments of the major helicopter manufacturers, were contacted for helicopter primary use data. Only Bell Helicopters keeps accurate records, but only on the use of the helicopter at the initial sale. MBB has a record of its EMS helicopters.

4. National Business Aircraft Association (NBAA) - Mo Haupt.

Mr. Haupt of the NBAA provided helicopter specific data on corporate executive missions.

5. National Association of State Aviation Officials (NASAO)

NASAO and the Helicopter Association International are jointly developing a heliport directory. NASAO was contacted to see if any data was available.

6. Ray Raffensberger, President, Airborne Law Enforcement Association, Baltimore, MD.

Discussion of aviation use in airborne law enforcement, database in production.

7. Andy Yates, Executive Director, Professional Aeromedical Transport Association, Alexandria, VA.

Data on non-hospital-based aeromedical programs, membership breakdown.

8. Joel Schexnayder, Meteorologist, National Weather Service, Slidell, LA.

Weather information for the Gulf of Mexico, SAWRS information, buoy and seaman data.

9. Dr. Hsu, LSU Coastal Marine Studies Institute, Baton Rouge, LA.

Climatic data studies for Gulf of Mexico, archived SAWRS data.

10. Ed Essertier, Offshore Specialist, American Petroleum Institute, Washington, D.C.

Offshore, oil industry contacts.

11. Ms. Mary Blount, Public Information, U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Regional Office, New Orleans, LA.

Gulf of Mexico offshore maps, listing of platforms location and specifics.

12. Gene McQuitty, Ensearch Exploration, Dallas, TX.  
Critical price of gas.
13. Henry Christiansen, FAA Southwest Regional Office, Fort Worth, TX.  
HSAC quarterly meeting, offshore helicopter forecast, offshore CNS.
14. Alan Hanson, Meteorologist, National Weather Service, Lake Charles, LA.  
Gulf of Mexico SAWRS station data.
15. Ms. Maria Thompson, Offshore Oil Scouts Association, Chalmette, LA.  
Critical price of oil, active Gulf of Mexico rigs, offshore maps.
16. Dave Samuels, President, National Flight Paramedics Association, Phoenix, AZ.  
Non-hospital-based aeromedical programs, EMS accident database, membership breakdown.
17. Susan Baumgartner, Executive Director, National Flight Nurses Association, Rapid City, SD.  
EMS accident database, concerned nurses network, non-hospital-based aeromedical programs, membership breakdown.
18. Dave Smith, President, MBB Helicopter Corporation, West Chester, PA.  
EMS helicopter statistics, Vertiflite article, percent EMS in airborne law enforcement.
19. Bill Browder, President, Geo-Seis Helicopters, Inc., Fort Collins, CO.  
Helicopter missions; fire control support, exploration, pollution detection, power/pipeline patrol, survey.
20. Barth Bartholomae, President, Royale Helicopter Service, Inc., Burgettstown, PA.  
Helicopter missions; Herding/ranching, pollution detection.
21. Bob Cloud, Chief Pilot, Southern California Edison Company, Chino, CA.  
Helicopter missions; pollution detection.
22. Jim Lucas, Director of Operations, Briles Wing and Helicopter, Inc., Van Nuys, CA.  
Helicopter missions; pollution detection.

23. Jerry Shelley, Pilot, Alaska Helicopters, Inc., Anchorage, AK.

Helicopter mission; power/pipeline patrol, survey.

24. Carol Floyd, NTSB Accident Data Division, SP-0, Washington, D.C.

Rotorcraft accident data by mission, annual accident reports.

25. National Climatic Data Center, Asheville, NC.

Gulf of Mexico weather studies and SAWRS data.

26. Robert Breiling, Robert E. Breiling, Associates, Boca Raton, FL.

Rotorcraft accident data by mission type.

27. ASHBEAMS - Nina Merrill, telephone interview.

Ms. Nina Merrill is the Director of the American Society of Hospital-Based Aeromedical Services (ASHBEAMS, now the Association of Aeromedical Services AAMS). She was contacted by telephone to discuss her opinion of the trends in the EMS industry.

# ACRONYMS

AAMS	Association of Aeromedical Services (formerly ASHBEAMS)
AC	Advisory Circular
AGL	Above Ground Level
AIA	Aerospace Industries Association
ALEA	Airborne Law Enforcement Association
APS	Airport Planning Standard
APT	Airport
ASF	Airport Specific File
ASHBEAMS	American Society of Hospital-Based Emergency Aeromedical Services (currently AAMS)
ASI	Applied Systems Institute
ATC	Air Traffic Control
CFR	Code of Federal Regulations
CNS	Communications, Navigation, and Surveillance
CZ	Control Zone
DEC	Digital Equipment Corporation
EMS	Emergency Medical Service
ENG	Electronic News Gathering
FAA	Federal Aviation Administration
GOM	Gulf of Mexico
HAI	Helicopter Association International
HFI	Helicopter Foundation International
HSAC	Helicopter Safety Advisory Conference
IFR	Instrument Flight Rules
LAX	Los Angeles International Airport
LOCID	Location Identifier
Loran-C	Long-Range Navigation
MBB	Messerschmitt-Bolkow-Blohm
MMS	Minerals Management Service
NAS	National Airspace System
NBAA	National Business Aircraft Association
NFDC	National Flight Data Center
NTSB	National Transportation Safety Board
NWS	National Weather Service
OCS	Outer Continental Shelf
RMP	Rotorcraft Master Plan
SAWRS	Supplemental Aviation Weather Reporting Station
SCT	Systems Control Technology
SIAP	Standard Instrument Approach Procedures
SVFR	Special Visual Flight Rules
TCA	Terminal Control Area
TERPS	Terminal Instrument Procedures
VFR	Visual Flight Rules
VOR	Very High Frequency Omnidirectional Range
X-C	Cross Country